PATTERNS OF ATTENTIONAL BIAS IN CHILDREN WITH

RECURRENT ABDOMINAL PAIN AND

PAIN-FREE CHILDREN

by

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CHAPTER I

INTRODUCTION

The role of attention in the awareness of and response to pain makes it an important

cognitive function to study in recurrent pain conditions (e.g., Cioffi, 1991; Compas & Boyer,

2001; Eccleston, 1995a, 1995b; Eccleston & Crombez, 1999; Zeltzer, Bursch, et al., 1997;

Zeltzer, Bush, et al., 1997). Attention is a critical component in the experience of pain, as it

is involved in the process of orienting toward pain and appraising it as harmful or benign

(Compas & Boyer, 2001; Eccleston, 1995b; Eccleston & Crombez, 1999). Attention

continues to play an important role once pain has been detected, as it is involved in ongoing

activities such as monitoring subsequent internal and environmental events, and facilitating

pain responses (Compas & Boyer, 2001; Eccleston, 1995a; Eccleston & Crombez, 1999).   It

has been suggested that differences in these attentional processes are associated with the

degree to which pain is perceived as signaling harm to an individual, and the extent to which

an individual is fearful of pain (Eccleston & Crombez, 1999).

Difficulties in attentional processing have been hypothesized to have a role in the

maintenance of recurrent abdominal pain (RAP; Zeltzer, Bursch, et al., 1997; Zeltzer, Bush,

et al., 1997). RAP is a pediatric condition in which three or more episodes of abdominal pain

occur over a period of at least three months and interfere with the child's activities (Apley,

1975). Zeltzer and colleagues have suggested that children who experience RAP are

hypervigilant for pain sensations, and once pain has been detected, are less able than healthy

peers to disengage attention from pain, resulting in increased pain fear and anxiety, which

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further magnifies pain (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997). However, no study to date has compared children with RAP to pain-free children in their attentional response to pain. Thus, a primary goal of this study is to compare children with RAP and pain-free children in their pattern of attentional orienting to physical threat. The model proposed in this study draws upon theories of chronic pain and attention and is based on the integration of relevant findings from the adult and pediatric pain literature. Further, this study will investigate the content specificity of attentional bias for physical threat stimuli by testing bias for other threatening information. In addition, psychological correlates of attentional bias to physical threat will be investigated, including anxiety symptoms, current affect, and beliefs regarding the severity of abdominal pain threat.

This paper first presents current models of pain, attention, and perceptions of pain threat, emphasizing the importance of attentional processing and threat perception in chronic pain conditions. Research on biases for the selection of threatening stimuli for attention in adults and children with chronic pain is reviewed. Also, because of the attentional bias toward threat that has been well-documented in anxiety disorders, research on attentional orienting in pediatric and adult anxiety disorder patients is considered.

Models of Pain

Acute, everyday pain signifies tissue damage and the need to prevent further damage. For example, acute pain signals protective reflexes to withdraw a hand rapidly from a hot stove and notifies the brain to organize adaptive behaviors, such as staying clear of the burner. After injury, pain encourages reduced activity and behaviors that promote healing, which usually results in the lessening and ultimate disappearance of pain, and a return to

regular activities. In this example, attending to pain sensations is adaptive for healthy functioning. However, not all pain subsides with healing nor has an identifiable biological cause. For chronic pain, the failure of purely biological explanations for symptoms has been widely reported. In addition, associations among physical impairment, pain, and disability have been shown to be modest at best (e.g., Guite, 2001). It is now recognized that the experience of pain includes dynamic and bidirectional relations between biological, psychological, and environmental components (Merskey, 1979). A brief overview of the evolution of our understanding of pain follows.

Traditional Biomedical Perspectives on Pain

Traditional medicine had a dichotomous view in which symptoms were seen as either somatogenic or psychogenic. When somatogenic, medical treatments were based on the principle of biomedical reductionism, in which a medical condition is reduced to a single etiology. It was believed that pain signified tissue damage, and when no tissue damage could be ascertained, the condition was considered psychogenic. Thus, accompanying features of chronic conditions, such as depression, sleep disturbance, and psychosocial disability, were considered reactions to a disease and therefore of secondary importance. When these secondary reactions did not abate upon the disease's cure, they were suspected to be of psychological origin.

Gate Control Theory of Pain

Failure of purely biological explanations to account for symptom variation is common in cases of chronic pain. In the 1960s, dissatisfaction with the conventional model

of pain led to the formulation of the Gate Control Theory of pain (GCT) (Melzack & Casey, 1968; Melzack & Wall, 1965). GCT recognized that the experience of pain is an ongoing sequence of activities that are modifiable by a variety of excitatory and inhibitory influences, including ascending and descending central nervous system (CNS) activity.

GCT posits gate-like mechanisms in the dorsal horn of the spinal cord that regulate the passing of information from the body to the brain. When the body experiences tissue damage, pain receptors at the site send a signal via nerve fibers to the dorsal horn. Here, the opening of the gates allows pain signals to continue their travel to the brain. The opening of the gates is influenced by the body's sensory-discriminative, motivational-affective, and cognitive-evaluative systems, which may act to inhibit, excite, or modulate the passage of pain information (Melzack & Casey, 1968). In this way, GCT helps explain variations in pain experience that tissue damage cannot explain. For example, severe injury experienced during a dangerous situation may not be perceived as painful until an individual has escaped to safety, as in the case of injuries experienced during wartime battles. If the experience of pain were not delayed, the individual's escape from danger might not be possible. Thus, GCT posits that input from the brain regarding factors unrelated to tissue damage (as in the perception of a threatening situation) influence the pain experience. GCT's emphasis on the modulation of inputs in the dorsal horn of the spinal cord and the dynamic role of the brain in pain perception has resulted in the integration of psychological variables into current research on and treatment of pain (Drossman, 1996; Melzack, 2001; Turk, 1996).

Current Perspectives on Recurrent Abdominal Pain

Evidence for biological and psychological heterogeneity in disorders such as diabetes,

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cancer, and inflammatory bowel disease led to George Engel's proposal of a

"biopsychosocial" model of illness (Engel, 1977, 1980). Engel suggested that illness is the

product of biological, psychological, and social subsystems interacting at multiple levels.

According to this model, the intensity of symptoms and a patient's response to them are

influenced by a wide range of factors, such as the degree of tissue damage, as well as the

patient's attentional focus, mood, prior learning history, cultural background, environmental

contingencies, social support, and financial resources. Biopsychosocial models have further

stimulated research on the contributions of psychosocial components to the etiology and

maintenance of illness (Drossman, 1996; Turk, 1996).

Recurrent abdominal pain (RAP) is the most common chronic pain complaint in

children. It is defined as having at least 3 episodes of abdominal pain in a three-month

period, and is rarely associated with organic disease (Apley, 1975). Patients with RAP report

higher levels of emotional distress than their healthy peers (Garber, Zeman & Walker, 1990;

Walker, Garber & Greene, 1993). A biopsychosocial perspective on RAP integrates

biological, psychological, and socio-contextual factors in reciprocal and dynamic interactions

that cause and perpetuate pain (for reviews of these factors, see Zeltzer, Bursch, et al., 1997;

Zeltzer, Bush, et al., 1997; Scharff, 1999; Walker, 1999). This perspective is consistent with

the GCT of pain. Biological factors in RAP include physical pathology or physical changes

in the gut that generate nociceptive signals transmitted to the brain. Psychological factors

include beliefs about pain developed from prior pain and illness experiences; attention to

pain signals and appraisal of pain sensation, including interpretation of its meaning and one's

ability to cope with it; temperament; and emotional states. These psychological factors are

involved in the modulation of nociceptive signals from the gut. Socio-contextual factors

include behavior of significant others (e.g., caregivers, teachers, and peers), which may shape children's pain responses and beliefs by encouraging healthy and active responses to pain or adoption of a sick role, and by providing children with a model for pain behavior when responding to their own pain. Thus, current views of RAP integrate multiple components in the experience of pain and pain-related disability.

In discussions of the interruptive function of pain, Eccleston, Crombez and colleagues argue that pain interrupts and demands attention in order to promote escape from pain (Crombez, Baeyens, Vansteenwegen & Eelen, 1997; Eccleston, 1995a, 1995b; Eccleston & Crombez, 1999). In their cognitive-affective model of the interruptive function of pain, these authors argue that pain has an attentional processing priority by activating a primitive defensive system that urges escape from somatic threat (Eccleston & Crombez, 1999). They suggested this function is normal and adaptive for short-lived pain, but is problematic in the case of chronic pain, in which escape from pain may not be possible (Aldrich, Eccleston, & Crombez, 2000; Eccleston & Crombez, 1999).

With respect to RAP, it has been proposed that children with RAP may be distinguished from healthy peers by their hypervigilance for abdominal pain (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997), which may facilitate interruptability of attention toward ongoing activities by pain. Once pain has been detected, children with RAP may be less able than peers to disengage attention from pain (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997). Furthermore, continuing participation in regular activities may require a high level of attentional effort in order to override the interruptive function of pain, and maintaining this attentional effort in response to chronic pain may be challenging over time (Compas & Boyer, 2001). This may lead to more pain-related disability, which reduces the

availability of distracting information and thus may promote increased attention to pain (Walker, 1999). Increased attention to pain also may result in greater fear and anxiety about pain ,which, in turn, magnifies pain sensations (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997). Thus, attentional processes have important implications for regulating the experience of pain.

Mechanisms of Attention

Capacity Models of Attention

Metaphorical accounts of attentional processing use analogies of a spotlight or zoom lens to describe the capability of attending to a limited number of events at any one time. These analogies reflect ideas described in capacity models of attention, which depict attention as a limited resource that can be allocated to the performance of tasks in the service of meeting current and future goals (Kahneman, 1973; Shiffrin, 1988). Cognitive tasks require varying amounts of attentional effort for performance. For example, attention may be automatically or environmentally directed toward certain information and events without conscious or deliberate effort (as when attention is drawn to a hand burning on a hot stove, or an approaching object in one's path). Conversely, large amounts of effortful attention are involved in tasks that require strategic planning and action, such as navigating novel or dangerous situations, and overcoming habitual behaviors. Some tasks, such as learning to ride a bicycle, require diminishing amounts of effortful attention over time and with practice, leaving more attentional resources available for other simultaneous actions that require

effortful attention (e.g., Logan, 1992a, b; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977).

Neurological Basis of Attentional Processes

Imaging studies of neurological structures, including positron emission tomography (PET), functional magnetic resonance imaging (fMRI), and depth electrical recordings, have contributed to our current understanding of the neurological basis of attention (e.g., Luck & Hillyard, 2000; Posner & DiGirolamo, 2000). Three neural networks have been implicated in the process of attending to sensory input: a posterior system that allows attention to be disengaged and shifted to different locations, an executive anterior system that is involved in the detection of target stimuli, and a vigilance system that influences both the anterior and posterior networks by increasing the efficiency of orienting by the posterior system and suppressing activity in the anterior system. These networks function together to facilitate detecting, engaging with, and disengaging attention from internal and external events.

The posterior attention network involves portions of the parietal cortex, parts of the midbrain's superior colliculus, and associated thalamic areas of the pulvinar nucleus. Current models of sensory orienting describe these brain areas working together to disengage attention from its current focus, bring attention to a target location in space, and restrict input to the indexed area (Posner, 1995).

The executive anterior system is distributed among the mid-prefrontal cortex, including the anterior cingulate gyrus and the supplementary motor area. This system is active in a wide variety of situations involving the detection of events and facilitation of conscious, effortful behavior (Posner & Petersen, 1990). Detecting a target causes

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interference in attention to other targets. That is, multiple sensory input channels can be monitored simultaneously with little or with no interference, but when a target is detected, the probability of detection of a target on other channels is greatly restricted (Duncan, 1980). Conflict trials of the Stroop task (described below) produce activation within the anterior cingulate gyrus of the frontal midline, supporting this network's role in executive control of target recognition and response (Posner & Rothbart, 1998).

The vigilance system involves the locus coeruleus's primary norepinephrine input to the cortex (Posner & Rothbart, 1992). This system is activated when an individual is required to maintain an alert state, such as in the foreperiod of a reaction time task, and when attending to a source of signals while waiting for a target to occur (see Posner & Petersen, 1990, for a review).

Together, these three networks of the brain's attention system work to facilitate responses to internal and external events. A decrease in metabolic activation of the anterior cingulate has been demonstrated during maintenance of vigilance, reflecting the elimination of extraneous thoughts that might interfere with target detection. The vigilance system further enhances target detection through the locus coeruleus's primary norepinephrine input to areas of the parietal cortex, where it connects with the posterior system (Morrison & Foote, 1986). These functions result in an increase in the speed of object recognition (Posner, 1978).

Attentional Engagement and Interruption

When attention is oriented toward a particular location, information at that location is processed with increased efficiency, while processing of information at other locations is less

efficient (Posner & Rothbart, 1992). This effect of orienting toward a location has been described as selection, and continued selection of a location or stimulus has been described as attentional *engagement* (Posner & Rothbart, 1992). In order to promote functioning in unpredictable environments, attentional processing must balance the need for attentional engagement with information pertaining to a current goal against the need for interruption by incoming information, which may be appraised as having a higher priority for attentional selection and continued engagement (Allport, 1989). It has been suggested that either or both of these processes may be impaired in patients with RAP and other chronic pain conditions, who may frequently select pain for attention and have difficulty disengaging their attention from it to other inputs (e.g., Eccleston, Crombez, Aldrich, & Stannard, 1997; Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997). For chronic pain patients, a bias to select pain for attention may contribute to symptom maintenance and related emotional distress and disability by prioritizing information related to pain over other information (Pincus & Morley, 2001; Crombez, Hermans, & Adriaensen, 2000).

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Influences of Threat Perception and Attentional
Processes on the Experience of Pain

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Pain Beliefs and Appraisals

Theoretical literature on pain beliefs and appraisal suggests that the degree to which pain is perceived as threatening influences attentional processing (e.g., Eccleston & Crombez, 1999; Lazarus & Folkman, 1984). According to the stress and coping theory of Lazarus and colleagues (Lazarus & Folkman, 1984; Smith, 1991; Smith & Lazarus, 1990), prior-held beliefs about pain and context-specific appraisals of a given pain sensation shape

an individual's perception of the implications of pain for an individual, or perceptions of pain threat. Beliefs are "preexisting notions about reality which serve as a perceptual lens, or a 'set'" (Lazarus & Folkman, 1984, p. 63). Threatening beliefs about pain, such as the belief that pain is a signal of impending harm or sustained damage, may make important contributions to the pain appraisal process.

Appraisals are evaluations made in a specific context that determine whether or not an event will be stressful, such as appraisal of a particular pain episode as harmful or benign. Two forms of appraisal, primary and secondary, are important in this evaluation. Primary appraisals of pain evaluate its significance for one's well-being, including evaluations of the intensity and frequency of pain symptoms, as well as the severity of an individual's pain condition (e.g., prognosis and expected duration). As pain is typically undesirable for children, primary appraisals of pain essentially include evaluations of whether or not harm has been sustained or is anticipated. Secondary appraisals are assessments of one's potential for coping with a pain episode, including perceived efficacy for problem-focused and emotion-focused coping responses. For a child with RAP, secondary appraisals of pain include assessments of whether or not the child can do something to end or alleviate the pain episode, and/or effectively regulate the negative emotions associated with it and continue with regular activities. Although primary and secondary appraisals describe evaluations of different concepts, Lazarus and Folkman note that they are interdependent, and probably influence each other. Although not specifically addressed by Lazarus and colleagues, their theory and new research (Walker, Smith, Garber, & Claar, 2005) suggests that if children are confronted repeatedly with abdominal pain, appraisals of the pain are likely to be similar over time, giving rise to an appraisal style or characteristic way of evaluating the threat of

pain for the individual, contributing to beliefs about pain.

Studies of patients with chronic pain indicate that pain beliefs and appraisals have important associations with the experience of pain. Several studies note that improvements made during adult pain treatment programs are associated with changes in pain beliefs (e.g., Jensen, Romano, Turner, Good, & Wald, 1999; Jensen, Turner, & Romano, 2001; Turner, Jensen, & Romano, 2000). For example, one study found that decreases in the belief that pain signals damage was associated with decreases in patient disability, and decreases in the belief that one is disabled was associated with decreases in pain intensity, disability, and depression (Jensen, et al., 2001). In addition, a recent examination of coping with RAP found that prior-held pain beliefs and episode-specific secondary appraisals were important in predicting pain coping strategies, which, in turn, were related to reports of somatic symptoms and emotional distress (Walker et al., 2005). These findings provide support for the role of threat perception in the experience of pain and related distress and disability.

The perception of pain threat may result in emotional states that facilitate attentional orienting to and engagement with pain, and hinder attentional shift from pain. According to Lazarus and Folkman, "fear is the manifestation of a specific stressful appraisal" (1984, p. 70). Individuals who perceive pain as threatening may report elevated fears regarding pain and other aspects of physical health. Common fears reported by adult pain patients with chronic pain are manifest in specific concerns regarding undiagnosed problems causing pain, avoidance of pain exacerbation, and avoidance of situations in which pain episodes would be particularly unpleasant (e.g., Kori, Miller, & Todd, 1990; Waddell, Newton, Henderson, Somerville, & Main, 1993). Chronic pain conditions, in which attempts at pain control fail and escape from pain is impossible, provide ample opportunities for pain-related fear and

worry to thrive (Aldrich et al., 2000; Eccleston & Crombez, 1999). Researchers have suggested that the perception of pain threat and experience of related emotional distress may result in a vigilant attentional style that prioritizes pain over other concerns and facilitates attentional interference of pain (Aldrich et al., 2000). Furthermore, pain-related fear may result in increased use of pain coping strategies that attempt to avoid pain (Asmundson, Norton, & Norton, 1997). Thus, the perception of pain threat and experience of related emotional distress may have important associations with attentional orienting toward or away from pain.

Studies of patients with chronic pain conditions suggest a relation between pain fear and attentional bias for pain, and highlight the role of pain-related fear in the experience of disability related to pain (Crombez, Eccleston, Baeyens, Van Houdenhove, & Van den Broeck, 1999; Crombez, Vlaeyen, Heuts, & Lysens, 1999). One study found pain-related fear to be superior to pain characteristics (e.g., pain intensity, duration) in predicting disability in adult patients with chronic low back pain (Crombez, Vlaeyen, et al., 1999). In addition, a separate study found that the combination of high pain intensity and high pain-related fear was the best predictor of attentional interference on an attentionally-demanding task for adult patients with various chronic pain conditions (Crombez, Eccleston, et al., 1999). The authors of this study suggested that pain-related fear facilitates and intensifies the attentional interruption by pain.

In summary, theory suggests that perceptions of pain threat have implications for the critical role of attentional processes in the experience of pain. Preliminary evidence supports the role of pain beliefs and appraisal of threat in the experience of pain and related distress and disability. Additional evidence suggests a link between the experience of pain fear,

which may be a manifestation of high threat appraisal, and attentional interference by pain.

A Model of Pain, Threat, and Attention

Figure 1 presents a model of the roles of attention and threat perception in the experience of pain. At the onset of a pain sensation, attentional processes orient the individual to pain in varying degrees. For example, pain may consume the majority of attentional resources such that prior engagement with other events is completely disrupted, or it may be attended to vaguely or not at all. Pain intensity is hypothesized to influence this process. Evidence suggests that higher levels of pain intensity demand higher degrees of attentional orienting than lower levels of pain intensity (e.g., Eccleston & Crombez, 1999).
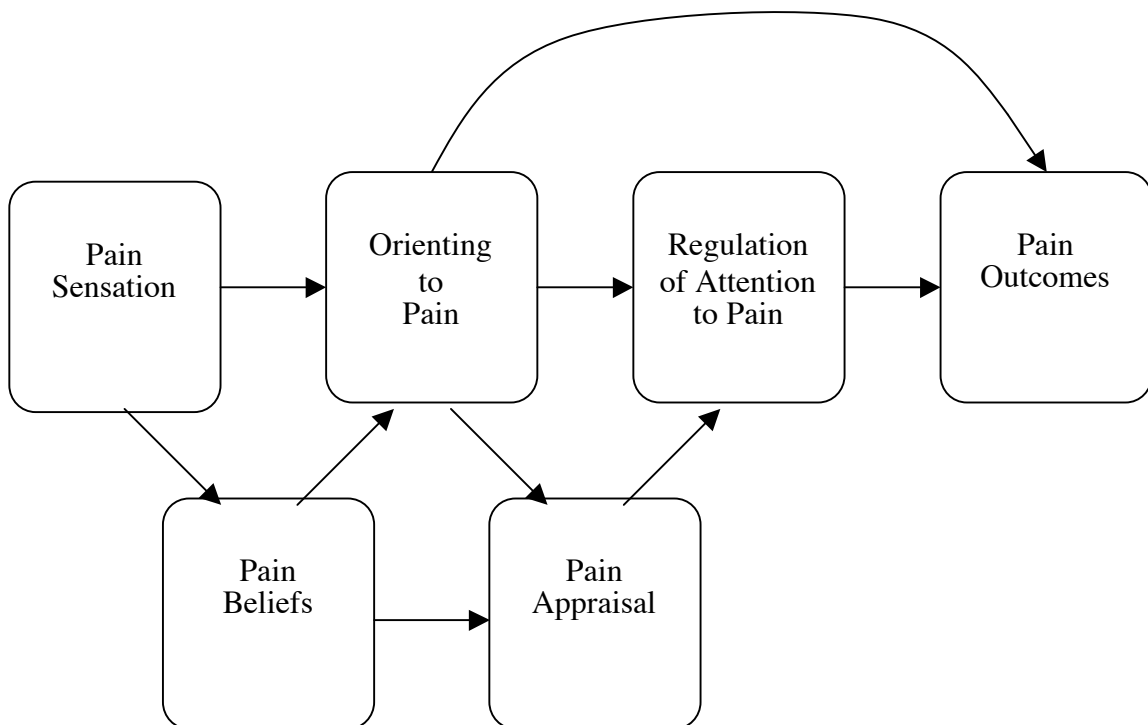
Figure 1. Model of the roles of threat perception and attentional processing in the experience of pain.

Following this initial orientation to or detection of pain, self-regulatory processes, such as sensory monitoring or distraction, facilitate attentional engagement with or shifting from pain. These regulatory processes influence later pain symptoms and/or emotional distress and disability. For example, studies have shown that sensory monitoring of pain facilitates a quicker return to regular activities than avoidance of pain sensations, theoretically through its attention to symptoms and resulting awareness of decreases in pain intensity (Cioffi & Holloway, 1993). In addition to its indirect influence through regulatory strategies, attentional orienting to pain is hypothesized to directly influence pain outcomes. For example, if attention frequently orients to pain sensations, pain frequency is likely to be reported as high. However, if attention is infrequently interrupted from other tasks and directed toward pain sensations, pain frequency may be reported as low.

Theoretical literature on pain beliefs and appraisal suggests that the degree to which pain is perceived as threatening influences attentional orienting to, engagement with, and shifting from pain (e.g., Eccleston & Crombez, 1999; Lazarus & Folkman, 1984). For example, a strong belief that pain is a signal of unavoidable harm may facilitate attentional orienting to a pain sensation. Following this orientation, appraisals of the pain sensation and one's efficacy for coping with it are hypothesized to influence whether or not and to what degree an individual continues to attend to pain (Eccleston & Crombez, 1999). For instance, if an individual appraises pain as signaling harm and oneself as incapable of coping with it, the individual may be more likely to attend to pain (e.g., by ruminating about pain) and less likely to shift attention away from pain. Theory (Lazarus & Folkman, 1984) and preliminary evidence (Walker et al., 2005) suggest that these appraisals are influenced by pain beliefs;.

For instance, a strong belief that one can cope with pain regardless of its severity will influence perceptions of individual pain episodes such that they are appraised as having low threat value.

Attentional and threat perception factors are hypothesized to contribute individually and in concert to pain outcomes including episode frequency and severity, condition duration, and related emotional distress and disability. Although depicted linearly here, these processes occur in a reciprocal fashion, with components depicted as outcome variables influencing components described as causal agents, both within and across pain episodes. For example, it is likely that past successes or failures in dealing with pain influence beliefs of one's vulnerability to pain, and the tendency to attend to future pain sensations. These processes are presented here from a unidirectional vantage for the ease of discussion, and to highlight the role of attentional orienting in setting the stage for pain appraisals, responses, and outcomes.

<center>Attentional Processes and Pain</center>

If pain indeed demands attention and urges escape (Eccleston & Crombez, 1999), effortful coping strategies may be required to override the inclination to engage attention with pain in attempt to alleviate it, since attempts to alleviate pain may be futile in the case of chronic pain (Aldrich et al., 2000). However, children may differ in their ability to engage in pain responses that require a high level of attentional focus (Compas & Boyer, 2001). In particular, Zeltzer and colleagues (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997) have suggested that children with RAP have difficulties shifting their attention away from pain. In this case, initial orienting of attention to pain would be particularly troublesome for

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children with RAP, as it would set off a cycle of continued attention to pain, and perhaps futile efforts to control pain (Aldrich et al., 2000). Furthermore, if children with RAP are hypervigilant for pain sensations, as suggested by Zeltzer and colleagues (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997), this cycle may be more easily and more often engaged for these children than for children who do not experience frequent abdominal pain episodes.

Attentional Bias

Initial orientation to threat cues is potentially important for people with chronic pain because it sets the stage for future pain responses (e.g., Compas & Boyer, 2001). Furthermore, evidence suggests that direction of attention (toward or away from pain) has important implications for chronic pain outcomes, with avoidant responses relating to poorer outcomes than responses that focus attention on pain, or, at minimum, acknowledge the presence of pain (e.g., Suls & Fletcher, 1985; Thomsen, Compas, Colletti, Stanger, Boyer, & Konik, 2002).

Researchers have begun to investigate whether patients with chronic pain can be differentiated from pain-free individuals by a bias to select pain over other stimuli for attention. In laboratory tasks, selection of target stimuli for attention is demonstrated by facilitation of responses to target stimuli when compared with responses to control stimuli. Attentional bias toward target stimuli occurs when responses to target-cued trials are consistently facilitated. In contrast, attentional bias away from target stimuli occurs when responses to target-cued trials are consistently slowed. Studies have found attentional biases for disorder-specific stimuli in children and adults with various psychological disorders, including anxiety (e.g., Mogg, Mathews, & Eysenck, 1992; Vasey, Daleiden, Williams, &

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Brown, 1995) and post-traumatic stress disorder (Bryant & Harvey, 1995; Pine, Mogg, Bradley, Montgomery, Monk, McClure, et al., 2005) as well as in adults with depression (e.g., Williams, Duncan, & Nulty, 1986). For example, attentional bias to social threat words was found in patients with social phobia, but not patients with depression or healthy volunteers (Öhman & Soares, 1994). Because health issues are a dominant concern for children with RAP (Lipani, Van Slyke, & Walker, unpublished data), it appears reasonable to suggest that children with RAP may have an attentional bias to pain and health-related stimuli (Boyer, 2002) and that these biases may have similar implications for chronic pain patients.

Adaptations of the Stroop task (see Williams, Matthews, & MacLeod, 1996, for a review) and the Probe Detection task (dot probe task; MacLeod, Matthews, & Tata, 1986) have been used in the study of attentional bias for negative stimuli, such as physical and social threat words and faces with angry or sad expressions. Response time in both tasks serves as the measure of attentional bias. The Stroop task requires participants to name the print color or background color of negative words representing a concern of interest and neutral words, ignoring word content. Slowed color-naming of negative words relative to neutral words is taken to indicate that attention was drawn to the negative word's content, interfering with color naming, indicating selective attentional processing of cues representing a relevant concern (Riemann & McNally, 1995). However, some suggest that slowed color-naming may reflect avoidance of threat cues (e.g., De Ruiter & Brosschot, 1994).

A common variation of the dot probe task briefly presents a negative and a neutral stimulus on a computer screen, such as a negative and neutral word (e.g., "hurt" and "door") or a negative and neutral face (e.g., an angry face and an expressionless face). Following

each presentation, participants must identify the location of a probe (usually a small dot) that replaces one of the stimuli. Faster response time when the dot replaces negative stimuli and slower response time when the dot replaces neutral stimuli are taken to indicate attentional bias *toward* negative stimuli, which could reflect a prioritization of threat stimuli in information processing. In contrast, slowed response time when the dot replaces negative stimuli and faster response time when the dot replaces neutral stimuli are taken to reflect attentional bias *away from* negative stimuli, which may reflect a tendency to avoid threatening stimuli.

In addition to measuring response facilitation or interference, the dot probe task permits measurement of attentional orienting at different points in time following the presentation of stimuli by varying the duration of time that stimuli remain on the screen before the probe appears. In studies of adult attentional processing, *supraliminal* presentations typically present stimuli for 500 milliseconds, which is long enough to allow conscious processing of stimuli (e.g., Mogg et al., 1992). Conversely, *subliminal* presentations appear so briefly that conscious awareness is reduced and participants do not report having viewed them. However, semantic processing of subliminal presentations remains sufficiently intact to demonstrate anxiety-related attentional biases in patients with high levels of anxiety (e.g., MacLeod & Rutherford, 1992; Mogg, Bradley, Williams, & Matthews, 1993). Subliminally presented words appear for as briefly as 14 milliseconds, followed by a mask of random letters or characters. At such brief presentation rates, patients with generalized anxiety disorder (GAD) exhibit a bias for negative information in general, whereas supraliminal presentations elicit a bias specifically to words related to their predominant concerns (e.g., Mogg, Bradley & Williams, 1995; Bradley, Mogg, Millar, &

White, 1995). Although both subliminal and supraliminal presentations permit the

measurement of early responses to stimuli, responses to subliminal presentations are thought

to provide a measure of automatic and pre-attentive orienting, and responses to supraliminal

presentations provide more time for attentional shift during controlled stages of processing

(see Mogg & Bradley, 1998, 1999; Williams et al., 1997, for reviews).

Although the Stroop and dot probe tasks essentially assess allocation of attention to

competing stimuli, they do not assess the same aspects of attentional processing. Whereas

the Stroop task requires the suppression of a response (to read the word), this is not true for

the dot probe task, which assesses allocation of visual attention (Mogg et al.,1992; Brosschot,

de Ruiter, & Kindt, 1999). An additional advantage of the dot probe task is that response

times differentiate attentional shifts toward or away from threat, thus providing a measure of

vigilance or avoidance (Brosschot et al., 1999). It is not clear whether interference on the

Stroop task reflects attention to or avoidance of the word's content (e.g., De Ruiter &

Brosschot, 1994).

Studies have used the Stroop and dot probe tasks to investigate attentional bias to

supraliminally-presented pain words in adults with chronic pain. Several studies found

interference effects for pain words when compared to neutral words on the Stroop task

(Beck, Freeman, Shiperd, Hambley & Lackner, 2001; Crombez, Hermans, Adriaensen,

2000; Pincus, Fraser, & Pearce, 1998; Pearce & Morley, 1989) and that this pattern of

responding was specific to pain patients versus healthy participants (Pearce & Morley, 1989).

Slowed color-naming latencies were not found for negatively valenced, non-pain words

(Beck et al., 2001; Crombez et al., 2000; Pearce & Morley, 1989) or words related to other

disorders (Crombez et al., 2000), suggesting that attentional bias in chronic pain patients is

specific to pain-relevant information. In addition, Crombez and colleagues found that this effect was specific to pain-sensory words (e.g., burning), but not pain-affect words (e.g., punishing), and that patients' level of pain intensity predicted this effect, with higher levels of pain intensity related to slower color-naming of pain words. Thus, there is some evidence to support the presence of attentional bias to pain words in adult patients with chronic pain.

However, several investigations did not replicate these findings (Asmundson, Carleton & Ekong, 2005; Asmundson, Kuperos, & Norton, 1997; Duckworth, Iezzi, Adams, & Hale, 1997; Snider, Asmundson, & Wiese, 2000). No difference was found between chronic pain patients' and healthy controls' responses to pain words on a Stroop task (Duckworth et al., 1997) or a dot probe task (Asmundson et al., 2005). Other studies of chronic pain patients found that depression and anxiety played important roles in attentional bias for pain words. Snider and colleagues reported that patients' color-naming response latencies differed for pain words relative to neutral words on a Stroop task only when responses were controlled for depression scores. Conversely, Pincus and colleagues (Pincus et al., 1998) found a trend for adult patients to show attentional bias toward pain words in a dot probe task, but when response times were controlled for depressive symptoms, no differences in response times were found between pain patients and healthy participants. Similarly, Asmundson and colleagues (1997) did not find differences in responses to pain words on a dot probe task between pain patients and healthy participants before or after controlling responses for depressive symptoms. However, dividing patients into groups based on their level of anxiety sensitivity (i.e., fear of anxiety-related sensations) revealed significant differences in responses to pain words. Patients with low anxiety sensitivity shifted their attention away from pain words, whereas patients with high anxiety sensitivity

did not demonstrate attentional bias toward pain words.

In their review of attentional bias and pain studies, Pincus and Morley (2001) suggested that differences in findings across studies may be due to a number of factors including small sample sizes, methodological differences between studies, and samples of pain patients that are heterogeneous with respect to pain condition and related emotional distress. They also suggested that the absence of consistent effects for pain patients performing the Stroop and dot probe tasks may be explained by additional attentional effort and strategy required of the tasks during experiences of pain. In line with this hypothesis, attentional bias studies of patients with specific fears or phobias have found reduced interference by information related to the phobia when patients are tested in the presence of the object of phobia (e.g., people afraid of snakes tested in the presence of a snake, Öhman & Soares, 1994). It has been hypothesized that the absence of interference under these conditions results from an increase in the effort required to perform the task (Williams et al., 1996).

Another possible explanation suggested for this lack of consistent findings is that chronic pain patients have acquired skills in managing their attentional resources during the experience of pain, and thus are able to override any bias to external pain information while experiencing pain and performing an attentionally-demanding task (Pincus and Morley, 2001). Researchers studying attentional bias to anxiety cues have used subliminal presentation rates to examine the possible functioning of attentional biases to pain before strategic skill overrides them (e.g., Mogg et al., 1993). However, the only study investigating preconscious attentional bias in adults with chronic pain to date did not find a bias to or from pain words presented subliminally (Snider et al., 2000). Thus, no clear

evidence exists to support the hypothesis that adults with chronic pain are overriding attentional bias during cognitive tasks that engage high levels of attentional effort.

The only study investigating attentional bias in children with RAP investigated their bias to pain words both supraliminally and subliminally (Boyer, 2002; Boyer et al., 2006). An additional category of words related to social concerns was included to test the specificity of bias for pain words versus another form of threat. Results indicated that patients with RAP showed attentional bias to both categories of threat words when words were presented subliminally, and avoided both categories of threat when words were presented supraliminally. This pattern of responding suggests that the attention of patients with RAP was at first drawn to threat words, and, following this initial orientation, patients shifted their attention away from threat, reflecting attentional avoidance; this was related to parents' reports of more pain and somatic symptoms. Furthermore, when patients' levels of negative affect were statistically controlled, results showed that negative affect accounted for the significant differences in bias scores. Boyer (2002) suggested that attentional biases to threatening cues are at least partly a function of concurrent negative affect for children with RAP (see also Luecken, Tartaro & Appelhans, 2004).

Vasey and colleagues (Vasey, El-Hag, & Daleiden, 1995; Vasey & Daleiden, 1996) note that attentional bias toward threat stimuli serves the ultimate goal of avoiding threatening events. For children with frequent abdominal pain, vigilance for pain is rewarded with early detection, which enables subsequent avoidance of pain and related emotional distress with minimum effort (e.g., avoiding the experience of abdominal pain by suppressing thoughts and ignoring signs of pain). In this way, an attentional bias toward threatening stimuli may function as an anxiety regulatory mechanism by fostering the early avoidance of

distress-promoting experiences. These processes may have been reflected in the subliminal attention toward pain and supraliminal avoidance of pain demonstrated by patients in Boyer's study. Despite the short-term benefits of this potential sequence, it is possible that bias toward threat will interfere with effective information-processing and coping responses (Compas & Boyer, 2001; Vasey & Daleiden, 1996) and perhaps lead to increases in pain intensity or experiences (Cioffi, 1991; Cioffi & Holloway, 1993). Nonetheless, because pain-free children were not included in Boyer's study of attentional biases to threatening stimuli in children with RAP, it is not known whether these biases and their relation to current affect exists for all children, or whether they are uniquely related to the experience of chronic pain.

Preliminary evidence from studies comparing children with low and high levels of anxiety symptoms or fears suggest that children with low levels of anxiety do not demonstrate an attentional bias to threat words (Martin, Horder, & Jones, 1992; Dalgleish, Taghavi, Neshat-doost, Moradi, Canterbury, & Yule, 2003; Vasey et al., 1995; 1996). However, these studies have been limited by small sample sizes, limited age ranges, and use of stimuli that were not rated by children for their threat value. Furthermore, children were not screened with respect to their somatic health. Thus, it cannot be determined from the current empirical literature on children with somatic or affective disorders whether attentional bias for physical threat words is unique to the experience of recurrent pain in children.

The degree of perceived threat has been investigated in relation to attentional bias for threatening stimuli. Using facial stimuli in a dot probe task, one study found that threat intensity of facial stimuli was related to patterns of attentional bias (Wilson & MacLeod,

2003). Responses to faces with expressions ranging in intensity from very low to very high

anger were presented to individuals with high or low levels of anxiety. Regardless of their

anxiety level, all participants directed attention away from mildly threatening faces and

toward strongly threatening faces. However, the intensity of stimulus threat required to elicit

attention to stimuli was dependent upon participants' anxiety level. Specifically, participants

who had low levels of anxiety continued to avoid facial stimuli of moderate anger levels,

while participants with high levels of anxiety oriented toward these same faces. From these

results, it appears that individuals' perceptions of the level of threat associated with stimuli

are important for eliciting attentional bias. For patients with chronic pain, attentional bias to

pain may depend upon the perceived intensity of pain threat. Differences between chronic

pain patients in threshold for appraising pain as threatening may account for differences in

attentional bias scores.

The failure of previous studies to consistently document attentional biases in chronic

pain patients might be due to differences in the threat value of pain stimuli for participants.

Thus far, general anxiety has been an inconsistent predictor of attentional bias scores in

patients with chronic pain. However, anxiety that is specific to physical health show more

promise in detecting participants who are threatened by pain stimuli and subsequently

demonstrate attentional bias for pain (Crombez, Eccleston, et al., 1999; Van Damme,

Crombez, Eccleston, & Goubert, 2004). A study of pain-free individuals performing a dot

probe task found that levels of pain fear determined participants' bias for pain words (Keogh,

Ellery, Hun, & Hannent, 2001). Participants who reported high levels of pain fear attended

toward pain words, whereas participants with low to moderate levels of pain fear showed no

such bias. Although participants in these studies did not experience chronic pain, these

results support the hypothesis set forth by Crombez and colleagues that pain-related fear promotes attentional interference by pain (Crombez et al., 1999).

To summarize, attentional bias to pain is likely to increase attentional disruption by pain, and possibly cause additional difficulties in subsequent regulation of attention to pain. Findings from experimental investigations of attentional bias for pain stimuli using the Stroop and dot probe tasks in adults with chronic pain and children with RAP have been inconsistent, perhaps owing to the many variations of stimuli and tasks used, as well as differences between participants (Pincus & Morley, 2001). Theoretical literature and recent studies of pain beliefs and threat appraisal suggest that perception of pain threat may be important in predicting the degree to which patients demonstrate attentional bias to pain.

The Current Study

Overview

Theoretical and empirical literature suggests that attentional processes play a role in the experience of chronic pain conditions such as RAP, the most common chronic pain condition in children. Specifically, it has been suggested that children with RAP demonstrate excessive vigilance for pain sensations, increasing the chances that pain will be detected (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997). They also may demonstrate an attentional bias to pain, increasing the possibility that their attention will be interrupted by pain sensations (e.g., Compas & Boyer, 2001; Boyer, 2002; Boyer et al., 2006). Using a dot probe task with carefully researched words regarding their appropriateness for children as young as 8 years, this study will be a first attempt to

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investigate whether patients with RAP differ from healthy children in attentional processing of physical threat cues presented at subliminal and supraliminal presentation rates. Furthermore, the content specificity of abdominal pain patients' attentional orienting to physical threat cues will be examined by comparing participants' attentional orienting to physical threat to their attentional orienting for a second category of threat cues, namely, social threat. Physical and social threat cues will be presented at subliminal and supraliminal speeds to examine initial and subsequent attentional orienting to threatening information.

A third focus of this study will be to investigate the relations between attentional orienting to threat stimuli and pain threat perception, anxiety symptoms, and current negative affect. Theory and preliminary evidence suggest that elevated levels of threat perception and anxiety symptoms contribute to biases to select threatening information for attention by creating a vigilant attentional style that prioritizes threat and facilitates attentional interference (e.g., Eccleston & Crombez, 1999; Mogg & Bradley, 1998, 1999). Therefore, patients with RAP who have more negative pain beliefs or perceptions of pain may have stronger attentional biases for pain and physical threat stimuli. Furthermore, as documented in previous research, children with higher levels of negative affect and/or higher levels of anxiety symptoms may demonstrate stronger patterns of attentional bias for physical and social threat stimuli. Thus, this study will investigate the relation of attentional bias for threat with these variables for pain-free children and children with RAP. Because of the generally low concordance between child-report and parent- or teacher-report of anxiety symptoms in children (e.g., see reviews by Greco & Morris, 2004 and Schniering, Hudson & Rapee, 2000), this study will attempt to improve upon previous research on the relation of anxiety to attentional bias by using children's self-reports of anxiety symptoms.

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Finally, pediatric research findings regarding gender differences in attentional bias to threat words have been inconsistent. Preliminary findings suggest that gender differences may exist for relatively healthy children (e.g., Vasey et al., 1996) but not for children with RAP (Boyer, 2002; Boyer et al., 2006). Additionally, little information is available regarding the relation of age to attentional bias for threat in patients with RAP. Therefore, exploratory analyses will examine the role of sex and age in attentional bias to threat words for children with RAP and pain-free children.

Hypotheses

Hypothesis #1: Nature of attentional bias patterns within groups. The primary aim of this study is to investigate the content-specificity of attentional bias in children with RAP. It is expected that attentional bias patterns for this group will largely replicate previous findings (Boyer, 2002; Boyer et al., 2006) such that children with RAP demonstrate attentional bias to both physical and social threat words presented at a subliminal presentation rate. At the supraliminal level, children with RAP are expected to show more avoidance of (attention away from) physical threat words than social threat words. Differences between attentional bias scores for physical and social threat words are expected to be small for this group relative to the attentional bias scores for children with RAP.

Hypothesis #2: Group differences in patterns of attentional bias. The secondary aim of this study is to test whether attentional bias patterns for physical threat words differ between children with RAP and pain-free children. Specifically, children with RAP are expected to demonstrate stronger attentional bias toward subliminally presented physical and social threat words than Well children. Furthermore, children with RAP are expected to

demonstrate stronger attentional avoidance of supraliminally presented physical threat words.

Hypothesis #3: Psychological correlates of attentional bias. First, the relation of state negative affect with attentional bias scores is expected to replicate the findings of Boyer (2002) for both children with RAP and pain-free children. Specifically, it is expected that stronger negative affect before the dot probe task will be associated with stronger attentional bias scores. Higher negative affect scores are expected to be related to greater bias for subliminally presented physical and social threat words, reflecting stronger bias toward threat. In addition, higher negative affect scores are expected to be associated with greater avoidance of supraliminally presented physical and social threat words.

Second, it is expected that anxiety symptoms will be related to attentional bias for children with RAP, as well as pain-free children. Using self-reports of anxiety symptoms, higher levels of anxiety symptoms are expected to be related to stronger attentional bias toward subliminally presented physical and social threat words, and stronger avoidance supraliminally presented physical and social threat words.

Finally, for children with RAP, attentional bias patterns for physical threat words are hypothesized to be related to perceptions of pain threat. Specifically, using self-reports of pain beliefs, it is expected that more threatening beliefs about pain will be related to greater attentional bias to subliminally presented physical threat words, and greater attentional avoidance of supraliminally presented physical threat words.

Exploratory Analyses: Examination of age and gender effects on attentional bias. Exploratory analyses will examine the role of sex and age in attentional bias to threat words for children with RAP and pain-free children.

CHAPTER II

METHODS

Participants

 Children were eligible for the study if they were between the ages of 8 and 16

years inclusive, had not had major surgery in the last year, and had no identified reading

disability or chronic health condition (other than chronic abdominal pain for children with

RAP). Information regarding children's somatic and affective distress was provided for

96% of participants by a caregiver. Participating caregivers included mothers (79%),

fathers (15%) and non-parent caregivers (e.g., grandparents; 2%).

 Children with RAP (the "RAP group") were 77 patients newly referred to the

Vanderbilt Pediatric Gastroenterology Clinic, or were recruited from a previous study of

children with RAP that recruited participants from this clinic. In an effort to restrict the

sample to only one form of chronic pain condition (Pincus & Morley, 2001) only children

experiencing functional abdominal pain meeting criteria for Apley's (1975) description of

RAP were invited to participate.[1] Thus, in the three months preceding the lab study,

patients in the RAP group experienced at least three episodes of abdominal pain that

interfered with their activities (Apley, 1975), and for which no medical evaluation to date

had identified an organic cause. Based on caregiver reported obtained at the time of their

initial clinic visit, 17% of these patients experienced abdominal pain on a daily basis,

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[1] Because frequent headaches are common in children with chronic abdominal pain (e.g., Hyams, Burke, Davis, Rzepski, & Andrulonis, 1996), children with RAP who also experienced chronic headaches were not excluded.

51% experienced abdominal pain several times per week, and 26% experienced abdominal pain once per week or less frequently; 62% of patients had experienced recurrent episodes of abdominal pain for more than a year. The average amount of time between initial clinic appointment and study participation date was four months (mean = 120.90 days, SD = 135.60 days). The time between clinic appointment and lab visit was within one month for 27.8% of patients, between one and six months for 48.5% of patients, between six months to one year for 13.9% of patients, and more than one year for 9.1% of patients.

The RAP group included 48 female and 29 male patients whose mean age was 11.79 years (SD = 2.18, range = 8 – 16 years). The majority of the patients were Caucasian (87.0%) and the remainder were African-American (5.2%), Asian-American (2.6%) or from other ethnic backgrounds (5.2%). In addition, 10.4% of children with RAP reported that they predominantly use their left hands for writing. The mean occupational status of their parents, based on the Hollingshead occupational scores that range from one to nine (Hollingshead, 1975), was 5.19 (SD = 1.17) or that of clerical workers, salespeople and small farm owners.

Pain-free children ("Well children") were recruited from a larger survey study conducted in public schools that took place, on average, approximately one year before the lab visit. The time between the survey study and lab visit was between two and six months for 40.8% of Well children, between six months and one year for 21.0% of Well children, and more than one year for 38.1% of Well children. At the time of the lab visit, Well children were excluded from the study if they had experienced moderate to severe pain (e.g., abdominal pain, headaches, and menstrual pain) once or more per month in the

preceding three months, or mild pain more than once per month during the preceding

three months. In addition, efforts were made to ensure that healthy participants were not

scheduled to participate following a recent illness episode or injury (e.g., flu) in the two

weeks prior to their study session. The Well group included 81 participants (35 female,

46 male) whose mean age was 11.78 years (SD = 2.32, range = 8 – 16 years). The

majority of the patients were Caucasian (97.5%) and the remainder were African-

American (2.5%). In addition, 9.9% of Well children reported that they predominantly

use their left hands for writing. The mean occupational status of their parents, based on

the 9-point Hollingshead occupational scores (Hollingshead, 1975), was 4.84 (SD = 1.04)

which falls between the category that includes skilled manual workers, craftsmen, and

law enforcement workers and the category that includes clerical workers, salespeople and

small farm owners.

Measures

Attentional bias

Children's attentional biases to physical and social-threat related information were

measured using a modified probe detection task ("dot probe task") introduced as the Dot

Game. As discussed above, variations of the dot probe task have been used in research with

adults and children. The current task uses threat words describing physical threat (e.g., pain,

disease) and social threat (e.g., loser, lonely). Procedures for selecting words followed the

protocols of Vasey and colleagues (Vasey, et al., 1995; 1996) and Boyer and colleagues

(Boyer, 2002; Boyer et al., 2006) with several important modifications that are detailed

below.

Word Selection Procedure. Words for the dot probe task were initially gathered from other dot probe studies (e.g., Boyer, 2002; Boyer et al., 2006; Vasey, et al., 1995; 1996). However, some of these words were at sixth-grade reading levels, and would require more advanced reading skills than the skills of many younger children in this study. Furthermore, previous studies using the dot probe task with children have selected negatively valenced and neutral words based upon adult emotional valence ratings. To create a list of words appropriate for this age group with respect to these issues, a research team of faculty members and graduate students collaborating on a larger study of attentional bias to threat in children generated additional words. All words were rated by children for their emotional valence, by teachers for their reading level, and by other graduate students for their relevance to the proposed categories of physical threat, social threat, and neutral words. The procedures and selection criteria for each form of rating are described below.

To obtain the threat value of words perceived by youngsters the same age as children completing the dot probe task, 454 students ages 8 to 15 in public schools were asked to rate the emotional valence of words. An initial pool of over 450 words was divided into 15 rating forms of 32 words each, with some duplication of words across forms[2]. Words predicted to have a positive emotional valence were included so that students would use a variety of rating points. Each word was rated with one of the

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[2] To determine whether younger and older students rated words similarly, 48 words were rated by children ages 8-10 years and children ages 11-15 years. Comparison of these ratings found differences between age groups to be insignificant.

following descriptors: "very bad," "bad," "a little bad," "not good and not bad," "a little good," "good," and "very good[3]." Descriptors were assigned numerical values of -3 to 3, respectively, and mean scores were computed for each. An average of 29 students completed each rating form, ensuring that a minimum of 24 students rated each word.

Initial inspection of the data revealed that forms from 23 participants were invalid due to pattern responding. After removing invalid ratings, the minimum number of students rating each word was 22. Average valence ratings were computed for each word. A word was considered "neutral" if the average rating of that word was between −1 and 1 (i.e., average rating between "a little bad" and "a little good"). A word was considered "threatening" if its average rating was between −1.5 and -3 (i.e., between "a little bad" and "very bad").

To confirm that words were reflective of the threat categories for which they were intended, twenty graduate students naïve to the purpose of the study were asked to categorize the words. Graduate students categorized an average of 85 words so that each word was rated by five students. Words appeared individually on Power Point slides, and were categorized as "positive", "social threat", "physical threat" or "does not fit any of these categories" on a numbered answer sheet. Threat words were included in the dot probe task only if a minimum of four students agreed upon their category (80% agreement). Similarly, neutral words were included only if a minimum of four students did not categorize them into the positive or one of the threat categories.

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[3] Words rated on the first three forms were rated on a 5-point scale with ratings of "really good," "a little good," "not good and not bad," "a little bad," and "really bad." Ratings from these forms were recoded to the seven-point scale such that "really good" and "really bad" were recoded as "very good" and "very bad," respectively, whereas the ratings "a little good," "not good and not bad," and "a little bad" were not recoded.

To ensure that words in the dot probe task could be read and understood by children as young as eight years, a third grade and a fourth grade teacher were asked to rate whether words were readable and comprehensible by children finishing third grade. Only words that were judged readable and comprehensible to this age group by both teachers were considered appropriate for the study.

The final list of 20 physical threat words, 20 social threat words, and 80 neutral words met the above criteria for emotional valence, category relevance, and readability. Each threat word was paired with a neutral word according to its number of letters. These pairs were inspected by the team of researchers and revisions were made so that no pair contained words with clear relations to each other (e.g., the original pairings of "glass" with "bleed" was revised because of the potential for glass to cause bleeding). Table 1 lists the 20 physical and 20 social threat words with their matched neutral words. In addition to these 40 threat-neutral word pairs, 20 length-matched neutral-neutral word pairs were included to control for response biases that might result from the expectation of negative words on each trial. In total, 60 distinct pairs of words were included in the dot probe task.

To inspect whether the physical and social threat words were similarly negative, and significantly more negative than neutral words, an analysis of variance (ANOVA) compared their emotional valence ratings. Results indicated that the valence scores for threat and neutral word categories were significantly different from each other, $F(2, 77)$ = 545.35, $p < .001$. A Scheffe's test indicated that the mean valence ratings for physical threat words ($M = -2.04$, SD = 0.36) and social threat words ($M = -2.04$, SD = 0.27) were not significantly different from each other, but that they were significantly different from

the neutral word valence ratings ($M = 0.30$, SD = 0.32). The internal consistency of both

groups of threat-neutral word pairs was examined for subliminal and supraliminal

presentation intervals (see below). The alpha reliability coefficient was .97 for physical

threat words presented subliminally and supraliminally, and .96 for social threat words

presented subliminally and supraliminally. In addition, an ANOVA comparing the length

of physical ($M = 5.40$ letters, SD = 1.98) and social threat words ($M = 5.25$, SD = 1.33)

did not reveal significant differences, $F(2, 77) = 0.35$, ns.

Table 1.

Threat Words and their Matched Neutral Words.

Physical Threat List		Social Threat List	
flu	lid	ugly	what
ill	cup	jerk	twig
stab	iron	dumb	pans
sick	lamp	hate	roof
pain	coat	snob	bark
hurt	then	dork	pile
burn	when	loser	floor
ache	clap	bully	round
germs	hills	enemy	fence
cramp	broom	idiot	stove
bleed	about	coward	magnet
injure	button	stupid	washer
disease	streets	teased	across
painful	address	lonely	faucet
throwup	balloon	insult	stairs
headache	backpack	disliked	mountain
accident	umbrella	crybaby	dresser
emergency	paperclip	unloved	evening
bellyache	newspaper	lonesome	railroad
stomachache	streetlight	unpopular	furniture

Dot Probe Experiment. Procedures for the dot probe task follow procedures of recent studies as closely as possible (e.g., Boyer, 2002; Boyer et al., 2006). Word pairs were presented on a 15-inch monitor of a Dell computer. The experiment was controlled and timed with E-Prime software (Psychology Software Tools, 2001). The order of presentation for the 60 word pairs was randomly generated by the computer for each participant. Each threat-neutral word pair was presented at a subliminal presentation rate and a supraliminal presentation rate. To control for order effects and prevent consecutive presentations of the same word pair at different presentation rates, their order was counter-balanced across the first and second halves of the experiment. Specifically, a pair that was presented subliminally during the first half of the experiment was presented supraliminally during the second half of the experiment, and a pair that was presented supraliminally during the first half was presented subliminally during the second half of the experiment. In total, each participant completed 120 distinct trials of the experiment. When participants completed the first half of the experiment, they were given a one-minute break during which they could rest their eyes.

During each trial of the experiment, a white addition symbol ("+") appeared as a fixation mark in the center of the screen for 1 second. Following the fixation mark, one of the 60 word pairs appeared on the screen either subliminally or supraliminally. All characters appeared in white Courier font on a black background, one above the other in the center of the screen, separated by 3 centimeters. The position of the threat word in the upper or lower position was balanced across physical threat-neutral and social threat-neutral word pairs. Following the word pairs, the dot probe, a period ("."), appeared in the same position as one of the words in the word pair, replacing upper and lower words with equal frequency

across trials. Participants were instructed to press a corresponding key as quickly and accurately as possible to indicate the position of the dot. Participants were instructed to press the "c" key when the dot appeared in the upper position and the "m" key when the dot appeared in the lower position. The keys were labeled "UP" and "DOWN," respectively. In addition, two small pictures of arrows were placed on the bottom border of the computer monitor in line with the "c" and "m" keys. The left arrow pointed upward as a reminder that the "c" key indicated the upper position, and the right arrow pointed downward as a reminder that the "m" key indicated the lower position.   These instructions, labels, and arrow illustrations were reversed for half of participants to control for hand dominance.

Subliminal and supraliminal presentation rates were timed according to the existing study of attentional bias in patients with RAP (Boyer, 2002; Boyer et al., 2006). Word pairs in the supraliminal trials appeared on the screen for 1250 ms, and pairs in the subliminal trials appeared for 20 ms. In order to prevent subliminally presented words from leaving a faded image after disappearing, identical strings of consonant letters (e.g., FWRTP and FWRTP) replaced the upper and lower subliminally presented words. The letter strings were composed of an equal number of letters as the words that they replaced. To match the total presentation time of supraliminal word pairs, letter strings appeared for 1230 ms after subliminal word pairs.

The computer recorded the rate and accuracy of participants' responses for each trial. Recorded latencies to threat-neutral word pair trials serve as the measure of selective attention. For each participant, attentional bias *toward* threat words is indicated by shorter response latencies on trials in which dot probes replaced threat words, and longer response latencies on trials in which dot probes replaced neutral words. An attentional bias *away* from

threat words, or an avoidance of threat words, is indicated by the opposite of these patterns. Specifically, longer response latencies for trials in which dot probes replaced threat words and shorter response latencies for trials in which dot probes replaced neutral words will indicate an attentional bias away from threat words. Patterns of selective attention for both supraliminal and subliminal trials are discussed below.

Awareness check. Following the Dot Probe task, an awareness check was administered to test whether participants could report reading subliminally presented word pairs. With the exception of a response prompt, the procedures of this task are identical to those outlined by Boyer (Boyer, 2002; Boyer et al., 2006). E-Prime software (Psychology Software Tools, 2001) was used to present the task, which was introduced to participants as the "Word Game." Similar to the subliminal presentations of word pairs in the Dot Probe task, an addition sign appeared on the computer screen for 1 second as a fixation point, followed by two words, one above the other, for 20 ms. Half of the trials presented real words (e.g., house, driveway) and the remaining trials presented nonsense words (i.e., pronounceable words with no meaning; e.g., blorky, snidbell). Length-matched, identical strings of consonant letters replaced the words for 1230 ms. Following the letter strings, a question mark ("?") prompted participants to indicate whether a real word or a nonsense word was presented. A 50% overall accuracy rate would indicate that participants were guessing and/or unable to read the words and identify them as real or nonsense.

Participants completed the awareness check in a similar manner to the dot probe task, except that no practice trials were administered, and participants were informed of the percentage of real and nonsense words. Participants rested their left index finger on the "c" key and their right index finger on the "m" key. The "c" key was labeled "YES" to indicate

that real words were presented, and the "m" key was labeled "NO" to indicate that real words were not presented. In addition to the key labels, small cards labeled "YES" and "NO" replaced the up/down arrow cards on the monitor to remind participants which key indicated yes and no. The keys' meanings and labels were reversed for half of participants to control for hand dominance. The computer recorded response latency and accuracy. Three physical threat word pairs, three social threat word pairs, and nine filler word pairs were included in the task. The computer presented 18 different trials in random order for each participant.

Current Affect and Somatic Symptoms

Following Boyer (2002), participants completed a brief mood rating scale prior to the dot probe task. Items were derived from the Positive and Negative Affect Scale (PANAS; Watson, Clark & Tellegen, 1988). Children were asked to rate how much they feel each of three positive emotions (happy, interested, and confident) and three negative emotions (sad, angry, nervous). According to Boyer (2002), these items were chosen for their relatedness to positive or negative affect, as well as their reading level. Each word appeared in the center of the computer screen above a 5-point Likert-type rating scale. In contrast to the self-ratings completed with paper and pencil in Boyer's (2002) study, the experimenter read the stem for each item, "How much do you feel…" followed by the affect word, and entered participants' responses directly into the computer using E-Prime software (Psychology Software Tools, 2001). Participants rated the extent to which each word applied to their current affect using response choices on the screen that ranged from "1 = not at all" to "5 = a whole lot." Ratings were recoded to a 0 to 4 scale. Recoded ratings of positive and negative emotions were averaged to yield indices of positive affect (PA) and negative affect (NA) before the dot

probe task, respectively.

Following the dot probe task, participants completed the Symptom Emotion Report (SER; Walker, Williams, et al., 2006) in a similar manner to the mood rating scale. The SER was developed to assess symptoms and emotions experienced by patients in association with abdominal pain episodes. Symptoms on the checklist were derived from a longer measure of children's physical symptoms, the Children's Somatization Inventory (Walker & Greene, 1989), an instrument designed to assess somatic symptoms in children with recurrent abdominal pain. The SER was administered after the dot probe task to avoid priming participants for the symptom/physical threat items that appeared in the dot probe task (Lundh & Czyzykow-Czarnocka, 2001). Modifications were made for this study to include additional items from the mood rating scale and to reduce the overall number of items. Because items are repeated from the mood rating scale completed before the dot probe task, the experimenter introduced the SER by asking participants to think carefully about how they are feeling "right now," and throughout the administration emphasized that participants should assess how they are feeling at that very point in time. Items appeared on the computer screen above the same five-point rating scale as the mood rating scale, which ranged from "1 = not at all" to "5 = a whole lot" and is recoded to a 0 to 4 scale. The experimenter read the stem for each item, "How much do you feel…" followed by each item as it appeared on the screen, and entered responses directly into the computer.

In addition to six affect items included to assess post-dot probe PA and NA indices, participants were asked to rate how much they were experiencing three gastrointestinal (GI) symptoms (stomach ache, stomach upset, feel like throwing up) and thirteen Non-GI symptoms (e.g., dizzy, tired, headache, back ache). Recoded ratings of GI and Non-GI

symptom items were averaged to create a GI Symptom Index and a Non-GI Symptom Index, respectively. Scores on the both indices can range from 0 to 4.

Reading Screener

Two subtests of the Woodcock Johnson-III Tests of Achievement (Woodcock, McGrew, & Mather, 2001) were administered to assess participants' reading ability. In subtest 1, Letter-Word Identification, participants demonstrated reading skills by reading a list of words. In subtest 17, Reading Vocabulary, participants demonstrated reading comprehension and knowledge of vocabulary by reading words and naming their synonyms or antonyms, and completing word analogies. Administration and scoring procedures follow a standardized protocol in which the examiner administers one or two examples before asking participants to complete the task. Correct responses for each subtest were summed and compared to norms based on a nationally representative standardization sample that yields grade equivalencies. The two subtest scores were averaged to obtain an estimate of reading ability.

Anxiety Symptoms

Children age 10 and over were invited to complete the Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997) after the study session, either on their own or with the help of an experimenter by phone. The MASC was completed after the dot probe task to avoid priming participants for the threat items that appeared in the dot probe task (cf. Lundh & Czyzykow-Czarnocka, 2001) and was typically completed on a different day to avoid participant fatigue. Children rated how often each

statement is true for them on a 4-point rating scale ranging from "0 = Never true about me" to "3 = Often true about me." The MASC consists of 39 items distributed across four major factors: (1) Physical Symptoms Scale (e.g., "My heart races or skips beats" and "I feel tense or uptight"), (2) Harm Avoidance Scale (e.g., "I try to do everything exactly right," and "I check to make sure things are safe"), (3) Social Anxiety Scale (e.g., "I worry about other people laughing at me," and "I worry about getting called on in class"), and (4) Separation anxiety/Panic Scale (e.g., "I try to stay near my mom or dad," and "I keep the light on at night"). In addition, the MASC yields a Total Anxiety Scale, which sums responses to items across the four main scales, and an Anxiety Disorders Index, which sums responses to items that have been found to differentiate children with a diagnosis of an anxiety disorder from children without a diagnosis. These six scales are based on factor analytic findings, and their sum scores can be converted to age and gender-based standard scores (*T*-scores). The MASC has been shown to have excellent internal reliability (e.g., March et al., 1997) and adequate test-retest reliability (e.g., March et al., 1997; March, Sullivan, & Parker, 1999).

Pain Threat Beliefs

Children with RAP age 10 and over were invited to complete the Pain Beliefs Questionnaire (PBQ; Van Slyke, 2001; Walker, Smith, et al., 2005) after the study session, either on their own or with the help of an experimenter by phone. Like the MASC, the PBQ was completed after the dot probe task to avoid priming participants for the threat items that appeared in the dot probe task (cf. Lundh & Czyzykow-Czarnocka, 2001) and was typically completed on a different day to avoid participant fatigue. The PBQ is grounded in the conceptual approach to appraisal and coping formulated by

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Lazarus and Folkman (1984) and includes subscales assessing primary and secondary characteristic appraisals or beliefs regarding abdominal pain. According to Lazarus and Folkman (1984), primary appraisal refers to perceived potential for or sustained harm. This is assessed by the PBQ with two subscales. The Primary Appraisal – Pain Episode subscale consists of eight items assessing the duration and intensity of pain episodes (e.g., "My stomach aches hurt a whole lot"). The Primary Appraisal – Condition Severity subscale consists of twelve items assessing the expected duration of patients' recurrent pain condition and the seriousness of their condition (e.g., "My stomach aches mean I have a serious illness"). Items are rated on a five-point scale ranging from "not at all true" to "very true" and are summed to yield a total score. Responses are scored such that high scores indicate appraisal of the condition as more serious.

Secondary appraisal refers to perceived efficacy for coping with a stressor. The Problem-Focused Coping Potential scale of the PBQ consists of six items referring to children's perceived ability to ameliorate their pain (e.g., "When I have a bad stomach ache, there are ways I can get it to stop"). The Emotion-Focused Coping Potential scale consists of six items referring to children's perceived ability to live with an unremitting pain condition (e.g., "I know I can handle it no matter how bad my stomach hurts"). Items are rated on a five-point scale ranging from "not at all true" to "very true" and are summed to yield total scale scores. Responses are scored such that high scores indicate appraisal of low coping potential.

Parental Report of Affective Problems and Somatic Complaints

Because Pincus and Morley's (2001) review of attentional bias studies with adult chronic pain patients suggests that differences between findings are due in part to study samples that are heterogeneous with respect to related emotional distress, levels of participants' somatic and affective distress were examined. To avoid priming children's attention to threat words in the dot probe task, parents provided information regarding children's trait affective distress and somatic complaints. Using the client-entry version of the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) on a computer, parents were asked to indicate the frequency of 118 problem behaviors in the past six months using a 3-point scale ("0 = not true," "1 = somewhat or sometimes true," and "3 = very true or often true"). The CBCL is well standardized and has adequate reliability and validity (Achenbach, 1991). It provides gender-based standard scores (*T*-scores) for eight scales of behavioral deviancy that are based on factor analytic findings. Several scales are relevant to this study. The attention problems scale includes ten items describing attention-related difficulties (e.g., "Can't concentrate," "Impulsive"). The somatic complaints scale lists 11 somatic symptoms, including seven "physical problems ***without known medical cause***" (e.g., "Rashes or other skin problems," "Vomiting, throwing up"). The anxious/depressed scale contains 13 items measuring anxious and depressive symptoms (e.g., "Nervous, high-strung, or tense," "Feels worthless"). The withdrawn/depressed scale consists of eight items measuring anhedonic and other depressive symptoms (e.g.," Enjoys little," "Withdrawn"). The social problems scale includes 11 items describing social difficulties (e.g., "Gets teased," "Lonely"). Although social problems have not been reported in children with RAP to date, this scale was

included in this study to examine the relation between social problems and participants'

attentional bias for social threat words in the Dot Probe Task. In addition to these scales,

several DSM-oriented scales were derived from the CBCL items for a number of

disorders based on judgments by experienced child psychology and psychiatry

researchers (Achenbach, Dumenci, & Rescorla, 2001). Two of these DSM-oriented

scales, anxiety problems and affective problems, are used to assess anxiety and

depressive symptoms in participants. Items in these scales are listed in Table 2.

Table 2.

Items from the Child Behavior Checklist (CBCL) in the DSM-Oriented Anxiety
Problems and Affective Problem Scales.

Affective Problems*
5. There is very little that he/she enjoys
14. Cries a lot
18. Deliberately harms self or
     attempts suicide
24. Doesn't eat well
35. Feels worthless or inferior
52. Feels too guilty
54. Overtired
76. Sleeps less than most kids
77. Sleeps more than most kids during
     the day and/or night
91. Talks about killing self
100. Trouble sleeping
102. Underactive, slow moving, or lacks energy
103. Unhappy, sad, or depressed

Anxiety Problems*
11. Clings to adults or too dependent
29. Fears certain animals, situations,
     or places, other than school
30. Fears going to school
45. Nervous, highstrung, or tense
50. Too fearful or anxious
112. Worries

*Items numbers in the table correspond to item numbers on the CBCL

Demographic Information

Parents completed a Demographic Form designed for this study to collect demographic information about participants and their families, including participants' ethnicity and families' socio-economic status.

Procedure

Following the protocol approved by the Vanderbilt University Institutional Review Board, parents of eligible children learned about the study during their initial phone call with a member of the research team. Interested families scheduled a visit to the Department of Psychology at a time that was convenient for them, and were sent a letter in the mail to confirm the date and time of their appointment and provide detailed directions to the building. Upon arrival, an experimenter reviewed the study procedures with children and parents, including a brief overview of several other activities unrelated to this study. Informed assent was obtained from children and informed consent was obtained from parents. Following consent procedures, parents were asked to join a second experimenter in another room to complete the Child Behavior Checklist and Demographic Information form, in addition to other measures unrelated to this study. Children were asked to use the restroom to avoid any need to take breaks during the experiment.

Next, children were invited to sit at a computer desk. Chairs were set 60 centimeters from the computer screen. The heights of the computer monitor and/or the chair were adjusted for adequate viewing of the monitor and optimum comfort. Specifically, the computer monitor was adjusted so that its center was at children's eye level, and the chair was adjusted so that children's arms bent in right angles at their elbows when their hands

rested on the computer keyboard. The experimenter applied sensors to three fingers of each

child's right or left hand to collect physiological information for a separate investigation.

The sensors were not applied to children's index fingers and therefore did not interfere with

their participation in the current tasks. During the study, children used their left and right

index fingers on the "c" and "m" keys, respectively. A halogen lamp was dimmed to a pre-

set low brightness to allow optimum viewing of the computer screen.

Experimenters first administered the mood rating scale to children. Next, children

received instructions for the dot probe task, and completed the six instructional trials,

followed by 12 practice trials. They were given opportunities to ask questions during each,

and before beginning the task. Children were asked not to speak with the experimenter once

they began the task. The experimenter excused herself from the area to complete other work

while the experiment took place. When participants completed half of the task, they were

given a one-minute break, during which they remained seated, but did not need to attend to

the computer monitor. Immediately following completion of the task, experimenters

administered the Symptom Emotion Report. Next, after completing several activities

unrelated to this current study, participants completed the Word Game awareness check.

Participants were then debriefed regarding the computer tasks and given an opportunity to

ask questions. To finish their session, participants completed the Reading Screener and

Edinburgh Inventory with the experimenter. Finally, parents rejoined their children in the

study room and were given an opportunity to have any additional questions answered. They

were paid $50 for their travel to the session and time spent participating in the study.

After the session, children ages 10 – 15 years were invited to complete

questionnaire packets at home. Children under 10 years were not invited to complete

these questionnaires as they might have difficulty reading questionnaires on their own.

Eligible children in the RAP group were asked to complete several questionnaires,

including the Manifest Anxiety Scale for Children and the Pain Beliefs Questionnaire.

Questionnaires completed by eligible children in the Well group also included the

Manifest Anxiety Scale for Children. Addressed, stamped envelopes were provided for

children to return the questionnaire packets by mail. Children who returned

questionnaire packets by mail or completed the questionnaires over the phone with an

experimenter within ten days of the study session received a $20 gift card to Target.

Children who completed the questionnaires after ten days received a $10 gift card to

Target. Of the 64 patients with RAP who were aged 10 years or older, sixty (93.8%)

completed a questionnaire packet. Of the 64 eligible Well children, 58 (90.6%)

completed a questionnaire packet.

CHAPTER III

RESULTS

Overview of Hypotheses to be Tested

The proposed study seeks to examine attentional bias for threat words in children with RAP and pain-free children. To summarize briefly, children with RAP are expected to demonstrate attentional bias to both physical and social threat words presented at a subliminal presentation rate, and show avoidance of physical threat words when compared with social threat words in the supraliminal presentation rate. Secondly, children with RAP are expected to demonstrate stronger attentional bias toward subliminally presented physical and social threat words, and stronger attentional avoidance of supraliminally presented physical threat words than Well children.

Regarding psychological correlates of attentional bias for threat, it is expected that higher negative affect before the dot probe task and higher levels of anxiety symptoms will be related to greater bias for subliminally presented physical and social threat words, and greater avoidance of supraliminally presented physical and social threat words. Furthermore, for children with RAP, it is expected that more threatening beliefs about pain will be related to greater attentional bias to subliminally presented physical threat words, and greater attentional avoidance of supraliminally presented physical threat words. In addition, exploratory analyses will examine the role of sex and age in attentional bias to threat words for children with RAP and pain-free children.

Participant Characteristics

The ratio of female to male participants was greater in the RAP group (62% female) than in the Well group (43% female), $\chi^2 (1) = 5.79$, $p < .05$. Means and standard deviations of other demographic characteristics and somatic, anxiety and depression symptom variables are presented in Table 3. For CBCL and MASC variables, normative data (T scores) are reported in the table, although raw scores were used in analyses to maximize the variance of the scores. A one-way ANOVA indicated that the RAP and Well groups did not differ with respect to mean age or reading screener score, Fs < 1. It is also noteworthy that the groups did not differ significantly with respect to parents' reports of attention problems, $F (1, 151) = 1.57$. However, the difference in socioeconomic status approached significance, $F = 3.67$, $p < .06$, with parents in the RAP group reporting higher status on the 9-point Hollingshead index of parental occupation. Hollingshead index scores were not related to attentional bias scores (see below) for the RAP or Well group (rs ranged from -.17 to .16, ps > .10) and therefore were not considered further.

Both child and parent reports generally reflected more somatic, anxious, and depressive symptoms in children with RAP compared with Well children. Regarding somatic symptoms and somatic/physiological symptoms anxiety, children with RAP reported higher levels of GI symptoms at the time of the task, $F (1, 156) = 13.61$, $p < .001$, and greater physical anxiety symptoms on the MASC, $F (1, 117) = 7.63$, $p < .01$. Furthermore, their parents reported on the CBCL that children with RAP experience higher levels of somatic complaints, $F (1, 151) = 62.48$, $p < .001$. Parents of children with RAP also reported that their children experience higher levels of anxiety/depressive

symptoms, F (1, 151) = 10.71, p < .01, withdrawn/depressive symptoms, F (1, 151) =

8.98, p < .01, affective disorder symptoms, F (1, 151) = 21.44, p < .001, anxiety disorder

symptoms, F (1, 151) = 15.02, p < .001, and social problems, F (1, 151) = 3.93, p < .05.

At the time of the task, children with RAP reported lower levels of positive affect than

Well children before and after the task, F (1, 156) = 4.52, p < .05 and 7.71, p < .01,

respectively. In addition, there was a trend for children with RAP to report a greater

overall number of anxiety symptoms on the MASC than Well children, F (1, 117) = 3.51,

p < .10. These differences reflect the somatic, depressive, and anxious difficulties

reported for children with RAP in the literature (e.g., Boyer, 2002; Boyer et al., 2006;

Walker, Garber, Greene, 1993).

Preliminary Analyses

Response Latency Data Cleaning

Procedures from other dot probe tasks were followed to remove outlier data that

most likely reflect faulty responding (e.g., Mogg et al., 1995). First, probe detection

latencies less than 100 ms and greater than 4000 ms (4 seconds) were excluded.

Response latencies less than 100 ms are thought to be impossibly fast, and may result

from holding the response key from the previous trial or responding haphazardly or

impulsively. Similarly, latencies more than 4000 ms could be due to lapses in the

participant's attention, or difficulty with the keyboard's functioning or the computer's

timing. One response latency was faster than 100 ms and 51 response latencies were

slower than 4000 ms. Dropping these response latencies resulted in the removal of

Table 3.

Participant Characteristics by Group.

| | RAP Group | | Well Group | |
	M	(SD)	M	(SD)
Mean Age	11.79	(2.18)	11.78	(2.32)
Mean Reading Screener score	8.00	(2.92)	8.21	(2.56)
Hollingshead Index	5.19[+]	(1.17)	4.84[+]	(1.04)
Positive Affect pre-DP	3.45[a]	(0.61)	3.67[a]	(0.69)
Negative Affect pre-DP	1.52	(0.42)	1.54	(0.42)
Positive Affect post-DP	3.14[b]	(0.76)	3.46[b]	(0.68)
Negative Affect post-DP	1.36	(0.45)	1.42	(0.34)
GI Symptoms post-DP	1.38[c]	(0.66)	1.09[c]	(0.25)
Non-GI Symptoms post-DP	1.79	(0.59)	1.76	(0.56)
Somatic Complaints T score (CBCL)	61.62[c]	(8.46)	52.51[c]	(4.27)
Anxious/Depressed T score (CBCL)	57.95[b]	(7.91)	54.28[b]	(6.08)
Withdrawn/Depressed T score (CBCL)	57.81[b]	(8.89)	53.83[b]	(5.63)
Anxiety Problems T score (CBCL)	58.71[c]	(7.75)	54.30[c]	(5.99)
Affective Problems T score (CBCL)	58.63[c]	(7.82)	53.44[c]	(5.69)
Social Problems T score (CBCL)	56.10[a]	(7.48)	53.70[a]	(5.91)
Attention Problems T score (CBCL)	55.65	(7.10)	53.85	(6.29)
Physical Anxiety Scale T-score (MASC)*	12.15[b]	(7.30)	8.69[b]	(6.30)
Harm Avoidance Scale T-score (MASC)*	16.86	(5.38)	16.54	(5.03)
Social Anxiety Scale T-score (MASC)*	12.66	(6.11)	11.65	(5.79)
Separation/Panic Scale T-score (MASC)*	8.27	(5.06)	7.21	(4.78)
Anxiety Disorder Index T-score (MASC)*	13.85	(5.07)	13.14	(4.38)
Total Anxiety Scale T-score (MASC)*	49.94[+]	(17.79)	44.09[+]	(16.24)
Primary Pain Condition Appraisal Score*	1.80	(0.75)	N/A	
Primary Pain Episode Appraisal Score*	2.37	(0.84)	N/A	
Problem-Focused Secondary Appraisal*	1.84	(1.02)	N/A	
Emotion-Focused Secondary Appraisal*	2.46	(0.86)	N/A	

DP = dot probe task; *Participants 10 years and older.
$p < .10^{+}$ $p < .05^{a}$ $p < .01^{b}$ $p < .001^{c}$

0.41% of the 12,640 response latencies (80 threat word trials X 158 participants).

Second, latencies of inaccurate responses (i.e., incorrectly noting the placement of the dot

probe) were dropped from analyses, resulting in the removal of 478 response latencies

(3.78% of total threat word trials). Finally, to reduce the effect of within-participant

outliers, response latencies greater than two standard deviations below and above each

participant's mean were removed. There were 211 and 652 response latencies that fell

below and above two standard deviations from the individual participants' mean,

respectively. The average number of removed within-participant outlier response

latencies was 5.5, and no participant had more than 10 responses dropped. This resulted

in the removal of 6.83% of the total response latencies for threat word trials.

Validation of the Subliminal Condition

To investigate whether participants could consciously read subliminally presented

words and respond to the awareness check at a better-than-chance rate, mean response

accuracy on the Lexical Decision ("Word Game") task was calculated for each

participant and compared to the expected range of scores for the task following the

procedures of Boyer (2002). With 18 trials in the task and a hypothetical probability of

.50 being correct on each trial, the expected number of correct responses for each

individual is 18 x .50 = 9. The standard deviation of number of correct responses is the

square root of (18 x .50 x .50) = 2.12. The critical value of a two-tailed, .05 level t-test

with 49 - 1 degrees of freedom is 1.98. If participants are unable to consciously read the

subliminally presented words and thus performing at chance level, 95% of participants

should have correct responses between 9 + 1.98 x 2.12 and 9 - 1.98 x 2.12, or between

4.80 and 13.20. For this sample, participants' total number of correct responses ranged

from 4 to 14; three participants (1.9% of the sample) had four correct scores, three

participants (1.9% of the sample) had 14 correct scores, and 152 participants (96.2% of

the sample) had correct scores within the expected range of 4.80 and 13.20. Thus, the

number of accurate responses fell within the expected range for more than 95% of the

sample, suggesting that participants were not able to consciously read the words at this

level of exposure. The overall response accuracy for participants was 48.42%, which was

significantly less than a chance response accuracy of 50.00%, t (157) = -2.16, $p < .05$,

also suggesting that participants could not consciously read the words at this exposure

level.

Exploring Effects of Probe and Threat Word Position

To examine participants' attentional bias scores, mean response latencies were

computed for each type of threat word, in each exposure condition, for all combinations

of dot probe and threat word locations to examine the patterns of attentional bias scores.

Average scores for each group are listed in Table 4. To assess whether there are main

effects for either threat word position or probe position, a 2 x 2 x 2 x 2 x 2 repeated

measures ANOVA was conducted with these mean scores, using one between-

participants variable (RAP or Well group) and four within-participants variables: type of

threat word (physical or social), length of word exposure (subliminal or supraliminal),

threat word position (upper or lower) and probe position (upper or lower). Main effects

for threat word position or probe position could indicate that participants attended to

Table 4.

Response Latencies by Group for Threat Word Trials.

Exposure Condition	Threat Word Category	Threat Word Position	Probe Position	RAP Response Latency	Well Response Latency
Subliminal	Physical	Upper	Upper	681.86	680.44
		Upper	Lower	684.39	685.75
		Lower	Upper	660.85	687.73
		Lower	Lower	673.91	690.93
	Social	Upper	Upper	663.27	688.74
		Upper	Lower	710.49	680.36
		Lower	Upper	691.76	702.38
		Lower	Lower	684.04	695.80
Supraliminal	Physical	Upper	Upper	679.97	672.88
		Upper	Lower	667.02	663.75
		Lower	Upper	699.52	691.10
		Lower	Lower	666.47	681.74
	Social	Upper	Upper	698.11	702.90
		Upper	Lower	672.64	675.76
		Lower	Upper	676.17	701.15
		Lower	Lower	690.43	672.80

probes in one of the positions regardless of whether the threat word preceded a probe.

The ANOVA was conducted with the untransformed response latency data and repeated

with log transformations of the data. The two sets of analyses produced the same pattern

of results. Untransformed data are presented here for ease of comprehension.

Results indicated that there were no main effects for word position or probe

position, indicating that the position of the threat word or the dot did not alone account

for participants' attention and response latency. However, the effect of threat word type

approached significance, $F(1, 156) = 3.26$, $p < .10$, indicating a trend for participants to

respond more quickly to physical threat words (mean response latency = 679.33 ms, SD = 220.57) than social threat words (mean response latency = 687.98 ms, SD = 240.61). In addition, there was a significant interaction between exposure level and dot position, F (1, 156) = 6.89, p =.01, partial η^2 = .042. Follow-up t-tests indicated that participants responded faster to trials in which the words were presented supraliminally (within consciousness) and the probe appeared in the lower position (Mean = 673.82 ms, SD = 223.78) than they did when the words were presented supraliminally and the probe appeared in the upper position (Mean = 690.27 ms, SD = 237.71), t (157) = 2.29, $p < .05$, and when the words were presented subliminally (out of conscious awareness) and the probe appeared in the lower position (Mean = 688.21, SD = 239.24), t (157) = 2.11, $p <$ .05.

This interaction may reflect children's typical practice of attending to information sequentially from top to bottom, such as when information is read from the top to the bottom of a page or computer screen. Following this practice, participants may have read or at least attended to the top word followed by the bottom word. If so, they could have more readily detected probes that replaced the bottom word during supraliminal trials because they had previously attended to the upper word and were attending to the lower word when the probe appeared. Longer response latency to detect lower probes in subliminal trials (in which words were briefly presented and then masked by letters) could reflect the reduced time available for participants to attend to the bottom word by the time it was masked and the probe appeared such that participants were attending to the top word mask when the probe appeared in the lower position. Some early dot probes tasks instructed participants to read the top word aloud and found main effects for threat

word position (e.g., MacLeod et al., 1986). Because probe and word position data are not typically specified in recent published attentional bias studies (which do not require participants to read the top word aloud) it is unknown whether similar findings have emerged in other studies. Nonetheless, because these findings do not involve main effects of threat or probe position, they do not address a priori hypotheses based on previous studies and are not considered further (cf. Mogg, Mathews, Bird, & Macgregor-Morris, 1990).

Calculating Attentional Bias Scores

Following standard procedures, continuous attentional bias scores were created by collapsing the dot probe position by threat word position (e.g., MacLeod & Matthews, 1988). For each participant, mean response latency data from each trial are entered into the equation below to compute a continuous attentional bias score. This bias score reflects the magnitude of the attentional bias across all positions of the threat word and dot probe. Bias is operationalized as the response latency to detect the dot probe when it appeared in the same position as the threat word subtracted from the latency to detect the dot probe when it appeared in the opposite position on the screen as the threat word. Greater bias on this task, as indexed by a stronger tendency to attend toward the threat word than the neutral word, is reflected by shorter response times to detect the probe when the probe appeared in the same position on the screen as the word to which participants were attending, and longer response times when the probe and attended-to word are in opposite positions on the screen.

Attentional bias score = 1/2 [(UP/LT - UP/UT) + (LP/UT - LP/LT)]

In this equation, U = upper screen position, L = lower screen position, P = probe, and T = threat word. Thus, UP/LT is equal to the mean reaction time for a single participant when the dot probe is in the upper position and the threat word is in the lower position. In this equation, positive scores reflect an attentional bias toward threat, negative scores reflect a bias away from threat (i.e., avoidance of threat words), and a score of zero reflects no bias toward or away from threat. Separate bias scores for physical and social threat words at both presentation rates (subliminal and supraliminal) were computed for each participant, resulting in a total of four attentional bias scores for each child: subliminal attentional bias for physical threat words, subliminal attentional bias for social threat words, supraliminal attentional bias physical threat words, and supraliminal attentional bias for social threat words.

Attentional Bias Score Data Cleaning

Because the Reading Screener scores for two participants with RAP were below third grade level, the four attentional bias scores for these participants were compared with the mean attentional bias scores for the RAP group to estimate whether their performance on the dot probe task was influenced by lower reading ability. All four attentional bias scores for one participant (age 11, Reading Screener grade equivalency score = 2.65) were within two standard deviations of the respective mean attentional bias scores for the RAP group, and are therefore included in the following analyses. In contrast, the supraliminal physical threat and subliminal social threat attentional bias scores for the other participant (age 8, Reading Screener grade equivalency score = 2.8) were beyond two standard deviations from the RAP group mean for these scores. In

considering whether to retain this participants' data in the following analyses, the performance of younger participants on the dot probe task was considered further (see below). No Well children scored below the third grade level on the Reading Screener.

To reduce the effect of between-participant extreme scores, outliers were calculated separately for the RAP and Well groups because of the a priori hypotheses that these populations differ in attentional bias to threatening information. Group means for each threat word attentional bias score were calculated using participants' mean attentional bias scores. Participant scores that fell above or below two standard deviations from their respective group mean were omitted from further analyses. Following this procedure, 33 attentional bias scores (5.22% of the 158 participants' four scores) were dropped from the analyses. There were 11 Well participants and 9 participants with RAP who had attentional bias scores dropped. Eleven of these participants had one score dropped, five had two scores dropped, and four had three scores dropped.

Cursory examination of these outlying data points indicated that nearly half (48%) of these data belonged to eight- or nine-year-old participants. Furthermore, within each of the four attentional bias scores, the outlying data belonging to eight- or nine-year-old participants were not in uniform directions from the mean (i.e., for each type of attentional bias score, some outlying points were greater than and some were less than two standard deviations from the mean). This raised suspicion that younger children responded differently to the dot probe task than older children. However, year of age was not correlated with any of the attentional bias scores (rs ranged from -.15 to .10, ps > .20), suggesting that the larger discrepancies among eight- and nine-year-old participants'

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scores from the group mean scores were not due to a relation between maturation and magnitude of attentional bias.

Table 5 presents the number of participants of each year of age and their number of outlying data points. A chi-square statistic comparing the observed number of between-participant outlying data points for each year of age with the predicted number of outlying data points for each year of age (based on the number of children each year age in the sample) was significant, χ^2 (8) = 27.55, $p < .005$. To further examine possible discrepancies between 8- and 9-year old participants and older participants, a second chi-square statistic compared the number of outlying data points for 8-, 9-, and older participants (10- to 16-year-olds) with the predicted number of outlying data points for these three groups. This chi-square also was significant, χ^2 (2) = 20.06, $p < .005$, indicating that, compared to older participants, 8- and 9-year-old participants produced a greater than chance percentage of attentional bias scores that deviated from group mean attentional bias scores.

Table 5.

Between-participant Outlying Attentional Bias Scores.

Age	Number of Participants	Outlying Scores	
		Number	Percentage
8	5	5	25%
9	25	12	12%
10	33	8	6%
11	12	1	2%
12	16	5	8%
13	22	2	2%
14	23	1	1%
15	16	0	0%
16	6	0	0%

Dropping these outlying data points from further analyses would result in the reduction of the eight and nine year old participants' data by 25 and 12%, respectively, equal to more than 1.5 times the amount of data points removed for any other year of age group. With such a disproportionately large percentage of data removed for the eight and nine year old participants, children of these ages would be less well represented in further analyses than older children. Table 6 presents the RAP and Well groups' mean attentional bias scores for all participants, for eight and nine year old participants, and for participants age ten and older. Because eight and nine year old participants responded so differently to the task than the older participants, and because they would be poorly represented in further analyses following standard data cleaning procedures, the remaining analyses focus solely on children ages ten and older.

Table 6.

Attentional Bias Scores by Group and Age.*

	Exposure Condition	Threat Word Category	All Participants Mean (SD)	Older Mean (SD)	Younger Mean (SD)
Well	Subliminal	Physical	1.05 (125.86)	19.55 (83.87)	-68.58 (212.11)
		Social	- 0.90 (132.02)	-19.92 (93.30)	70.73 (214.40)
	Supraliminal	Physical	0.11 (82.26)	- 9.86 (76.64)	37.66 (93.86)
		Social	0.61 (158.65)	7.00 (105.16)	-23.46 (285.51)
RAP	Subliminal	Physical	- 5.26 (82.60)	- 9.40 (71.29)	15.08 (126.47)
		Social	27.47 (138.97)	16.60 (126.30)	80.98 (186.63)
	Supraliminal	Physical	10.05 (135.49)	26.26 (126.78)	-69.74 (153.56)
		Social	-19.86 (137.12)	-21.22 (145.41)	-13.17 (89.46)

* Data include outlier scores. Older = older than nine years of age; younger = eight and nine years of age.

Between-participant outliers were calculated again for the RAP and Well groups, this time for participants ages ten and older only. Group means for each threat word attentional bias score were calculated using participants' mean attentional bias scores as discussed above. Participant scores that fell above or below two standard deviations from their respective group mean were omitted from further analyses. Following this procedure, 27 attentional bias scores (5.27% of the 128 participants' four scores) were dropped from the analyses. There were 8 Well participants and 9 participants with RAP who had attentional bias scores dropped. Eleven of these participants had one score dropped, three had two scores dropped, two had three scores dropped, and one had four scores dropped. Of the seven years of age groups (10 years to 16 years of age) in this sample, no year of age group had more than 9% of its total attentional bias scores removed.

Table 7 lists group mean scores for each of the four attentional bias scores. Also included are the percentage of participants within each group whose mean attentional bias score reflected avoidance of threat (i.e., scores less than zero) and attendance toward threat (i.e., scores greater than zero). The group mean scores for each of the four attentional bias scores are also presented in Figure 1. Pearson's correlation coefficients were calculated to examine the relation among attentional bias scores within groups (see Tables 8 and 9 below). The Well group did not demonstrate significant relations among attentional bias scores, $ps > .10$. In contrast, for the RAP group, attentional bias for supraliminally presented physical threat words was positively related to attentional bias for subliminally presented physical threat words, $r = .28, p < .05$, and supraliminally presented social threat words, $r = .27, p < .05$. The relation between subliminal physical

threat and supraliminal social threat attentional bias scores approached significance, $r =$ .24, $p < .10$. Subliminal social threat attentional bias scores were not significantly related to other attentional bias scores for the RAP group.

Table 7.

Mean Attentional Bias Scores by Group.

	N	Mean (SD)	Range	%Avoid	%Attend
Children with RAP					
Subliminal Exposure					
Physical Threat	61	- 6.59 (62.66)	-132.75 - 130.96	54.1	45.9
Social Threat	59	17.32 (94.32)	-190.73 - 246.70	47.5	52.5
Supraliminal Exposure					
Physical Threat	62	28.27 (91.27)	-204.25 - 228.38	41.9	58.1
Social Threat	61	-10.75 (84.91)	-272.50 - 192.98	60.7	39.3
Well Children					
Subliminal Exposure					
Physical Threat	60	10.96 (63.33)	-131.63 - 149.67	45.0	55.0
Social Threat	60	-17.82 (69.39)	-197.41 - 132.00	58.3	41.7
Supraliminal Exposure					
Physical Threat	61	- 6.09 (61.96)	-161.04 - 140.13	59.0	41.0
Social Threat	61	- 3.67 (61.29)	-153.17 - 170.25	55.7	44.3

Hypotheses Testing

Nature of Attentional Bias by Group

The continuous attentional bias scores were used to test each of the hypotheses regarding attentional bias for threat words. To test the first hypothesis regarding the degree of attentional bias scores compared to a neutral attentional stance or absence of attentional bias, t-tests compared each of the group mean attentional bias scores to a score

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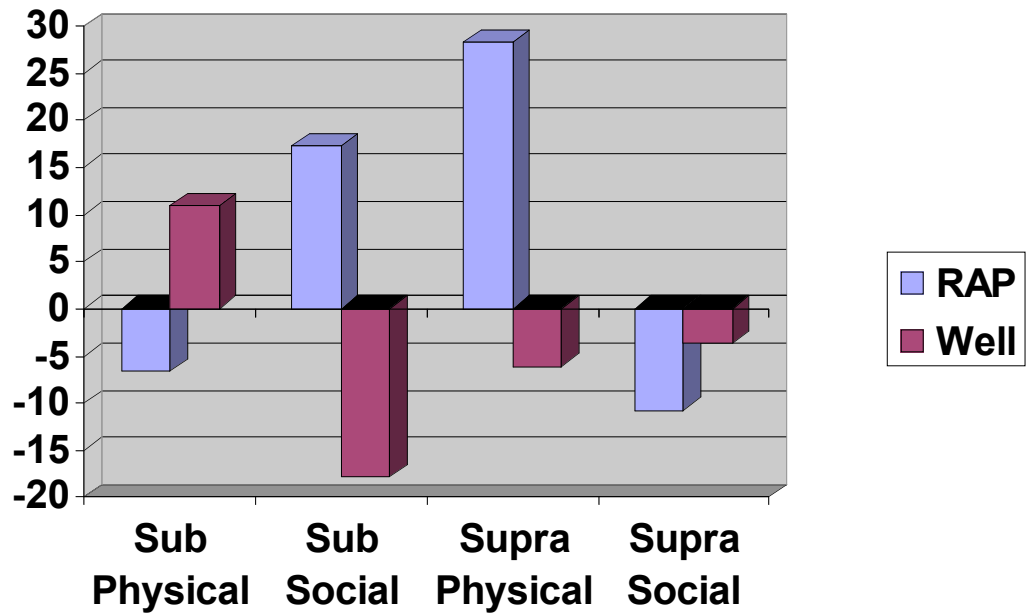
Figure 2. Attentional Bias Scores by Group.

of zero. Contrary to predictions, results indicated that children with RAP demonstrated attentional bias *toward* supraliminally presented physical threat words, t (61) = 2.44, $p <$ .05. Also in contrast to predictions, attentional bias scores for subliminally presented physical and social threat words and supraliminally presented social threat words were not significantly different from zero for the RAP group. Well children demonstrated a trend to avoid subliminally presented social threat words, t (59) = -1.99, p = .051. Attentional bias scores for subliminally presented physical threat words and supraliminally presented physical and social threat words were not significantly different from zero for the Well group. Thus, compared to a neutral attentional stance, participants with RAP demonstrated a bias only for threat words that are specific to their pain condition, and this bias was not demonstrated by Well children. However, the bias

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reflected attention *toward* physical threat words, as opposed to attentional avoidance of physical threat words demonstrated previously in children with RAP.

Comparison of Attentional Bias Scores

To test the second hypothesis regarding expectations that children with RAP demonstrate stronger attentional bias for threat words than Well children, a 2 x 2 x 2 x 2 repeated measures ANOVA explored differences between the groups with respect to the types of threat word (physical and social) and lengths of word presentation (subliminal or supraliminal). Gender was also included as a between-participants factor. As expected, the ANOVA yielded a three-way interaction effect for group, threat word type, and length of word presentation, $F (1, 109) = 5.66$, $p < .05$. In addition, there was a significant interaction of group, length of presentation, and gender, $F (1, 109) = 11.16$, $p < .01$. However, the four-way interaction between group, gender, threat word type and length of presentation was not significant, $F < 1$. Furthermore, there were no significant main effects, indicating that differences between the two groups' attentional bias scores depended jointly upon the length of word presentation and gender or the type of threat word.

To investigate the content-specificity of attentional bias to threat and determine whether patients with RAP demonstrated stronger attentional bias to threat words than Well participants, the effect of group was explored first for each exposure and threat word category. Results showed that children with RAP demonstrated greater attentional bias toward supraliminally presented physical threat words than Well children, $F (1, 121) = 5.95$, $p < .05$ (RAP group mean = 28.27, SD = 91.27; Well group mean = -6.09, SD =

61.96). Further, patients with RAP demonstrated greater attentional bias toward subliminally presented social threat words than Well children, $F(1, 117) = 5.37$, $p < .05$ (RAP group mean = 17.32, SD = 94.32; Well group mean = -17.82, SD = 69.39). Contrary to predictions, children with RAP did not differ from Well children in attentional bias for subliminally presented physical threat words or supraliminally presented social threat words. A separate ANOVA examining the effect of group for gender and length of presentation did not reveal significant differences.

To investigate subliminal and supraliminal threat orienting, attentional bias scores at different exposures were examined within the RAP and Well groups separately. For the RAP group, the ANOVA indicated a significant interaction effect for threat type and exposure level, $F(54) = 4.89$, $p < .05$. No main effects were found. Follow-up ANOVAs indicated that, when words were presented within conscious awareness, patients with RAP demonstrated greater attentional bias toward physical threat words than social threat words, $F(1, 57) = 5.22$, $p < .05$. At the subliminal level, patients with RAP did not discriminate between physical and social threat words, $F(57) = 2.13$, $p = .15$. Thus, patients with RAP did not discriminate between subliminally presented physical and social threat words, but when they could consciously read the threat words, they demonstrated more attentional bias for physical threat words than they did toward social threat words.

For the Well group, an ANOVA indicated a main effect for threat word type, $F(55) = 4.16$, $p < .05$. Follow-up ANOVAs indicated that, when words were presented subliminally, Well children demonstrated greater attentional avoidance of social threat words than physical threat words, $F(56) = 4.75$, $p < .05$. Well children did not

discriminate between physical and social threat words presented at the supraliminal presentation rate, $F (59) < 1$. Thus, Well children demonstrated greater attentional avoidance of social threat words than physical threat words when words were presented out of conscious awareness, but did not discriminate between supraliminally presented physical and social threat words.

Correlates of Attentional Bias for Threat

The third main set of hypotheses involved the relations of attentional bias to state affect and somatic symptoms and trait levels of somatic, anxiety and affective symptoms. For both groups of children, it was expected that greater attentional bias scores would be associated with less positive affect and more negative affect at the time of the task, and greater reports of anxiety and other internalizing symptoms. Furthermore, for patients with RAP, it was predicted that stronger attentional bias for physical threat words would be associated with greater GI and non-GI somatic symptoms and greater perceptions of pain threat associated with their recurrent pain condition. In addition, relations between attentional bias and demographic and illness variables were assessed to investigate alternative explanations of threat bias and to clarify the nature of attentional bias in this sample.

First, the relation of attentional bias scores to the number of days separating participants' initial assessment and completion of the attentional bias task was investigated. For the RAP group, no relation was found between attentional bias for supraliminally presented threat words and days between data collection points ($r = .08$ and $-.17$ for physical and social threat attentional bias, respectively, ns). However, an inverse relation was found

between subliminal attentional bias scores and number of days between data collection points. Greater attention toward subliminal physical threat was related to fewer days between data collection points ($r = -.27$, $p < .05$). In addition, there was a trend toward significance for a similar relation of attentional bias for subliminal social threat to number of days between assessment points ($r = -.23$, $p < .10$). Thus, when compared with patients who completed the dot probe task after more time had passed since their initial clinic appointment, patients who completed the task closer in time to their clinic appointment demonstrated greater attentional bias toward these threat words when they were presented at the subliminal exposure level. No significant relations were found between any of the four attentional bias scores and number of days between data collection points for the Well group (rs ranged from -.09 to .14, ps > .10).

Next, the time of day that participants completed the dot probe task and its relation to attentional bias scores were examined. Appointment times ranged from 9:00 a.m. to 6:30 p.m. for the RAP group, and from 9:00 a.m. to 7:30 p.m. for the Well group. The median appointment time was 1:30 p.m. for the RAP group and 1:00 p.m. for the Well group. For patients with RAP, the time of day that the task was completed was negatively related to attentional bias for supraliminally presented physical threat words, $r = -.27$, $p < .05$. Thus, earlier task completion times were associated with greater attention toward physical threat words when these words were presented within conscious awareness. Exploratory analyses conducted to gain insight into this finding revealed that none of the affect (i.e., positive and negative affect before and after the task) or somatic symptom (GI and non-GI somatic symptoms) assessments from the lab visit were related to the time of day that the task was completed, rs ranged from = -.01 to .24, ps > .05. For Well children, no relation was found

between the time of day that the task was completed and any of the attentional bias scores.

For the Well group, year of age was positively related to supraliminal social threat attentional bias scores, $r = .34, p < .01$. This relation reflects the trend for older participants to demonstrate more attention toward supraliminal social threat scores and younger children to demonstrate more avoidance of supraliminal social threat scores. This association was not found for the RAP group. No other demographic variable demonstrated a significant relation with any of the attentional bias scores.

Tables 8 and 9 respectively present correlations between attentional bias scores and psychological variables measured in both groups. Regarding children's self-reported affect before and after the task, surprisingly few relations with attentional bias scores were found for the RAP and Well groups. For the Well group, children who reported less positive affect before the task demonstrated stronger attentional bias toward subliminally presented physical threat words, $r = -.30, p < .05$. For the RAP group, no significant associations were found between affect and attentional bias for threat words.

Next, the relation of participants' attentional bias for threat words to GI and non-GI somatic symptoms at the time of the dot probe task was investigated. For the RAP group, there was a negative relation of attentional bias for supraliminally presented social threat words to levels of non-GI somatic symptoms, $r = -.38, p < .01$. This reflects a relation of greater attention toward threat to lower non-GI somatic symptom report at the time of the task, and of avoidance of threat to greater non-GI somatic symptom report at the time of the task. There were no significant associations between somatic symptoms and attentional bias for the Well group.

Table 8.

Correlations among Attentional Bias Scores, Psychological Variables, and Demographic Variables for the RAP Group.

AB = Attentional bias; DP = dot probe task; Anx = Anxiety; Sx = Symptoms. $p < .10^+$ $p < .05^a$ $p < .01^b$ $p < .001^c$

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1.	Sub Physical AB	-																					
2.	Supra. Physical AB	.28^a	-																				
3.	Sub. Social AB	.07	-.10	-																			
4.	Supra. Social AB	.24$^+$	.27^a	-.17	-																		
5.	Child Age	-.05	-.13	-.10	-.02	-																	
6.	Pos. Affect pre-DP	.10	.03	-.04	.04	-.05	-																
7.	Neg. Affect pre-DP	-.06	-.11	-.03	-.01	-.10	.13	-															
8.	Pos. Affect post-DP	-.02	-.08	.01	.01	-.02	.64^c	-.10	-														
9.	Neg. Affect post-DP	-.06	-.19	-.02	-.21$^+$	-.25^a	.10	.60^c	-.13	-													
10.	GI Sx post-DP	-.02	-.23$^+$	.09	-.18	-.24$^+$	-.06	.24$^+$	-.13	.49^c	-												
11.	Non-GI Sx post-DP	-.16	-.19	.06	-.38^b	-.09	.03	.52^c	-.10	.62^c	.40^b	-											
12.	Physical Anx. Sx.	-.26$^+$	-.40^b	.07	-.12	.05	-.25$^+$	.32^a	-.05	.26^a	.33^b	.43^b	-										
13.	Social Anxiety	-.10	-.14	.23$^+$	-.20	-.18	-.23$^+$	.29^a	-.19	.50^c	.27^a	.38^b	.42^b	-									
14.	Separation/Panic	-.07	-.07	.00	-.18	-.37^b	-.10	.28^a	-.11	.43^b	.07	.39^b	.33^a	.55^c	-								
15.	Anx. Disorder Index	-.13	-.21	.05	-.11	-.26$^+$	-.05	.22$^+$	.01	.45^c	.29^a	.45^c	.56^c	.81^c	.68^c	-							
16.	MASC Total	-.15	-.26^a	.11	-.20	-.28$^+$	-.13	.35^b	-.06	.51^c	.31^a	.48^c	.71^c	.81^c	.77^c	.92^c	-						
17.	Somatic Complaints	-.17	-.19	.14	-.21	.10	-.18	.12	-.17	-.08	-.08	.00	.25$^+$	.12	.01	.03	.13	-					
18.	Anxiety/Depression	.06	.07	.08	-.26^a	-.05	-.31^a	.05	-.18	.11	.28^a	.24$^+$	.29^a	.29^a	.09	.19	.26$^+$	.36^b	-				
19.	Withdrawn/Depress.	-.21	-.13	.11	-.25$^+$	.20	-.44^c	-.02	-.24$^+$	-.10	.15	.01	.33^a	.13	-.04	.00	.12	.51^c	.67^c	-			
20.	DSM Anx. Problems	.11	.06	.05	-.12	-.15	-.21	.07	-.11	.11	.22$^+$	.22$^+$	.33^a	.34^b	.24$^+$	.31^a	.38^b	.34^b	.89^c	.52^c	-		
21.	DSM Affect Probs.	-.19	-.16	.07	-.24$^+$	.13	-.40^b	-.01	-.23$^+$	-.07	.22$^+$	.11	.28^a	.11	-.04	.04	.11	.46^c	.72^c	.81^c	.53^c	-	
22.	Social Problems	-.09	-.07	.17	-.32^a	-.21	-.26^a	.14	-.12	.12	.34^b	.31^a	.39^b	.29^a	.37^b	.31^a	.44^b	.40^b	.62^c	.47^c	.68^c	.43^c	-

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Table 9.

Correlations among Attentional Bias Scores, Psychological Variables, and Demographic Variables for the Well Group.

AB = Attentional bias; DP = dot probe task; Anx = Anxiety; Sx = Symptoms. $p < .10^{+}$ $p < .05^{a}$ $p < .01^{b}$ $p < .001^{c}$

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Sub Physical AB	-																					
2. Supra. Physical AB	-.08	-																				
3. Sub. Social AB	-.19	-.02	-																			
4. Supra. Social AB	-.05	.10	-.21	-																		
5. Child Age	-.07	.07	.09	.34^b	-																	
6. Pos. Affect pre-DP	-.30^a	.18	-.09	-.08	-.38^b	-																
7. Neg. Affect pre-DP	-.16	.08	.01	.03	.13	.18	-															
8. Pos. Affect post-DP	-.05	-.12	-.14	-.13	-.50^c	.67^c	.03	-														
9. Neg. Affect post-DP	.07	.01	-.20	-.13	.01	.01	.42^b	.05	-													
10. GI Sx post-DP	-.05	.03	-.23$^+$	-.15	-.09	.16	.12	.17	.13	-												
11. Non-GI Sx post-DP	-.10	.15	-.14	-.12	-.16	.25^a	.13	.23$^+$	.13	.31^a	-											
12. Physical Anx. Sx.	.02	.19	-.05	-.26$^+$	-.23$^+$	.27^a	.19	.21	-.01	.14	.27^a	-										
13. Social Anxiety	-.06	.25$^+$	.06	-.37^b	-.22	.22	.10	-.03	-.08	-.07	.02	.49^c	-									
14. Separation/Panic	.09	.17	-.30^a	-.14	-.46^c	.24$^+$	-.08	.21	-.04	.10	.11	.36^b	.46^c	-								
15. Anx. Disorder Index	.00	.30^a	-.08	-.24$^+$	-.22$^+$	.26^a	.02	.14	-.11	.13	.20	.52^c	.70^c	.74^c	-							
16. MASC Total	.01	.25$^+$	-.10	-.29^a	-.37^b	.34^a	.07	.21	-.06	.08	.15	.72^c	.81^c	.76^c	.88^c	-						
17. Somatic Complaints	-.03	-.15	.13	-.01	-.01	-.02	-.11	-.12	-.02	-.04	-.15	.02	.17	.07	.08	.03	-					
18. Anxiety/Depression	-.04	-.06	-.06	-.06	-.15	.18	.01	.05	-.04	.01	-.01	.12	.24$^+$	.23$^+$	.15	.15	.58^c	-				
19. Withdrawn/Depress.	-.16	-.03	.22	-.07	.19	-.12	.00	-.29^a	-.02	-.07	-.06	.00	.04	.02	-.09	-.08	.47^c	.53^c	-			
20. DSM Anx. Problems	-.10	.02	-.16	-.03	-.15	.19	-.12	.15	-.02	.12	.05	.08	.18	.20	.11	.13	.42^b	.82^c	.38^b	-		
21. DSM Affect Probs.	-.04	-.07	.02	-.16	.06	-.02	-.01	-.19	-.03	-.05	.04	.04	.04	.04	-.06	-.09	.62^c	.65^c	.82^c	.48^c	-	
22. Social Problems	-.03	.10	.00	-.07	-.13	.20	.02	-.04	.02	.08	.09	.23$^+$	.25$^+$	.23$^+$	.17	.20	.70^c	.78^c	.62^c	.71^c	.74^c	-

Attentional bias scores demonstrated several significant relations with participants'

reports of anxiety on the MASC. For the RAP group, supraliminal physical threat attentional

bias scores were negatively related to physical anxiety symptoms, $r = -.40$, $p < .01$. In

addition, there was a significant negative relation of supraliminal physical threat bias to total

scores on the MASC, $r = -.26$, $p < .05$. These associations suggest that avoidance of physical

threat at the supraliminal level was associated with higher levels of physical anxiety

symptoms. In contrast, no significant associations were found for the RAP group between

social threat bias and anxiety scores.

Different relations emerged for the Well group between attentional bias scores and

MASC anxiety scores. In contrast to the RAP group, supraliminal physical threat bias was

positively related to anxiety scores. Specifically, Well children who demonstrated more bias

toward physical threat words had higher Anxiety Disorder Index scores, $r = .30$, $p < .05$. In

contrast to this positive relation, attentional bias for supraliminal and subliminal social threat

demonstrated negative relations with anxiety scores. Well children who demonstrated more

avoidance of supraliminal social threat reported more social anxiety, $r = -.37$, $p < .01$, and

higher MASC total scores, $r = -.29$, $p < .05$. At the subliminal level, Well children who

demonstrated more avoidance of social threat words reported higher levels of separation

anxiety/panic symptoms, $r = -.30$, $p < .05$.

Parent-reported internalizing symptoms demonstrated significant associations only

with attentional bias for supraliminally presented social threat words, and these associations

were found only for patients with RAP. Specifically, greater avoidance of supraliminal

social threat was significantly related to higher Anxiety/Depression, $r = -.26$, $p < .05$, and

Social Problem scores, $r = -.32$, $p < .05$. Contrary to predictions, attentional bias for physical

threat was not related to parental report of these internalizing symptoms nor children's somatic complaints.

Finally, for the RAP group, relations among attentional bias and perceptions of pain threat were assessed. Based on the conceptual framework of Eccleston and Crombez (1999), it was expected that beliefs regarding severity of pain episodes, severity of chronic pain condition and efficacy for coping with pain as assessed by the PBQ would be related to attentional bias for subliminally and supraliminally presented physical threat words. Results appear in Table 10. A significant relation was found for beliefs regarding pain condition severity to attentional bias for supraliminal physical threat words. Patients who perceived their pain condition as more serious demonstrated greater attentional avoidance of supraliminally presented physical threat words, $r = -.30$, $p < .05$. No other significant associations were found between attentional bias and pain beliefs.

Table 10.

Correlations among Attentional Bias Scores and Pain Belief Variables.

	1	2	3	4	5	6	7	8
1. Sub. Physical AB	-							
2. Supra. Physical AB	.28[a]	-						
3. Sub. Social AB	.07	-.10	-					
4. Supra. Social AB	.24[+]	.27[a]	-.17	-				
5. Condition Ap.	-.14	-.30[a]	-.08	-.16	-			
6. Episode Ap.	-.10	-.12	-.11	-.03	.65[c]	-		
7. Prob-Focus Cope Ap.	-.03	.03	.10	-.01	-.28[a]	-.59[c]	-	
8. Emo-Focus Cope Ap.	.07	-.05	.02	.05	-.36[b]	-.68[c]	-.58[c]	-

AB = Attentional Bias; Ap. = Appraisal. $p < .10^{+}$ $p < .05^{a}$ $p < .01^{b}$ $p < .001^{c}$

CHAPTER IV

DISCUSSION

The Nature of Attentional Orienting to Threat

This is the first study to use a laboratory task to compare children with RAP and pain-free children in their vigilance for physical threat. The study compared RAP and pain-free children with respect to three characteristics of attentional orienting to threat: (a) direction of bias toward versus away from threat, (b) specificity of bias for physical versus social threat, and (c) temporal features of attention (i.e., threat presented at subliminal and supraliminal levels). The association of physical threat attentional bias to state and trait levels of affect and anxiety and somatic symptoms was also examined. Results are discussed with respect to current models of chronic pain and potential implications of attentional bias for threat in children with RAP.

Study results support the hypothesis that children with chronic pain differ from healthy peers in attentional orienting to pain and somatic information. When words were presented within conscious awareness, patients with RAP demonstrated significantly greater attention to physical threat words compared to neutral words matched for word length and reading difficulty. In addition, patients with RAP exhibited significantly greater attentional bias to supraliminal physical threat than to supraliminal social threat. In contrast, RAP patients' attentional orienting to supraliminal social threat words did not differ from their attentional orienting to matched neutral words or from Well participants' orienting toward supraliminal social threat words. These findings support the idea that

patients with RAP are characterized by a bias to threat that is specific to their chronic pain condition rather than reflecting a more general attentional bias to any type of threatening information. Furthermore, patients with RAP demonstrated greater bias to physical threat words than Well children, whose attentional orienting to supraliminal physical threat words did not differ from their orienting to matched neutral words. Thus, the pattern of attention observed in RAP patients appears to be related to their experience of chronic pain and does not reflect a typical childhood response to pain-related information.

Models of chronic pain (e.g., Eccleston & Crombez, 1999; Zeltzer, Bursch, et al., 1997) and anxiety disorders (e.g., Mogg & Bradley, 1998, 1999) propose that these patients are biased to attend toward pain or other potentially negative information because of an oversensitive threat appraisal system that more readily assesses incoming stimuli as highly threatening and thereby causes and/or maintains facilitated engagement with and impaired disengagement from threatening information that is relevant to the patient's disorder. Results of this study provide evidence to support the presence of such a bias in children with RAP. The effect of this bias may include more frequent interruption of attention by pain sensations (Eccleston and Crombez, 1999). For children with poor ability to regulate the focus of their attention, more frequent interruption by pain may increase their focus on pain sensations, thereby increasing their anxiety and fear, which in turn can magnify subjective pain intensity (Walker, 1999; Zeltzer, Bursch, et al., 1997).

The study's finding of attentional bias for physical threat in children with RAP is in line with findings from several studies in the adult chronic pain literature, in which

pain patients with pain demonstrated slowed color-naming responses to pain words relative to neutral words on a modified Stroop task (Beck et al., 2001; Crombez et al., 2000; Pincus, Fraser, & Pearce, 1998; Pearce & Morley, 1989). However, results from other Stroop and from dot probe tasks have not replicated these findings, showing no evidence for interference (Duckworth et al., 1997) or no evidence for interference or bias until anxiety or depression levels were statistically controlled (Snider et al., 2000; Asmundson et al., 1997). The heterogeneity of pain disorders included in adult pain threat bias studies (e.g., musculoskeletal pain due to injury, Snider et al., 2000; chronic low back pain, Crombez et al., 2000) and the varying methodologies used may help explain the inconsistent findings in the adult literature (Pincus & Morley, 2001).

Given the high incidence of anxiety symptoms and disorders in RAP patients (e.g., Hodges, Kline, Barbero, & Woodruff, 1985; Walker et al., 1993), the literature on attentional bias associated with anxiety disorders also is relevant for comparison to the present study's findings. As one might expect given the overlap between RAP and anxiety, the bias toward threat demonstrated by patients with RAP in this study is consistent with attentional bias toward threat demonstrated by child and adult patients with anxiety disorders (see Hadwin, Garner, & Perez-Olivas, 2006, and Mogg & Bradley, 1998, 1999 for reviews of the child and adult anxiety literature, respectively). At supraliminal presentation rates, research has consistently shown that children with anxiety disorders have a bias to attend toward threat (e.g., Vasey et al., 1996, Dalgleish et al., 2003). Also at supraliminal presentation rates, research has shown that adults with anxiety disorders have a bias specifically for threatening information that is associated with their personal concerns (e.g., MacLeod & Rutherford, 1992; Mogg et al., 1992).

Thus, the relation of attentional bias toward physical threat found in this study for patients with RAP appears consistent with findings from studies of attentional bias in pediatric and adult anxiety disorders regarding attentional bias toward personally relevant threat.

In contrast, the only study to date that investigated attentional biases in children with RAP found that patients demonstrated attentional bias toward subliminally presented pain words, and attentional bias *away from* supraliminally presented pain words (Boyer, 2002; Boyer et al., 2006). Nonetheless, findings from the current study are consistent with the initial hypotheses set forth by Boyer, namely, that patients with RAP would demonstrate attentional biases toward supraliminal physical threat words. Although many similarities existed between this study and Boyer's study, there were differences between the study samples and procedure that may account for the differences in outcomes.

The patient samples in the current study and Boyer's study (Boyer, 2002; Boyer et al., 2006) were comparable in that they were composed of tertiary care patients and were similar with respect to patients' age, sex, and parent-reported anxious/depressive and somatic symptoms, and parental occupations. However, only patients with functional diagnoses completed the current study, whereas approximately 30% of patients in the Boyer study had an organic diagnosis. Although Boyer reported that functional versus organic diagnosis was not found to be related to attentional biases, it is unknown whether additional participants and greater statistical power would have revealed significant differences between the diagnostic groups. In addition, the current study was conducted in the Southeast region of the United States, while the Boyer study was conducted in the

Northeast, and it is possible that regional differences are related to differences in task performance. Thus, differences between the studies' patient samples may have contributed to differences in findings regarding attentional bias for threat.

Regarding study procedures, the dot probe task used in the Boyer study was nearly duplicated for the current study with the exception of the stimuli used. The current study used the same categories of threat words, stimulus display format, and timing of stimulus exposures as the Boyer study. However, only 17 of the 20 physical threat words and 12 of the 20 social threat words in this study appeared in the lists of 32 pain and 32 social threat words in the Boyer study. This resulted in only 53% and 37.5% overlap of physical and social threat stimuli, respectively, with the Boyer study. In addition, threat words in the current study included only those that received a specified level of negative valence ratings by children aged eight to fourteen, whereas threat word valence ratings in the Boyer study were obtained from undergraduate students whose perspective of threat may differ from that of children and adolescents. As reviewed above, theory (e.g., Eccleston & Crombez, 1999) and evidence (Wilson & MacLeod, 2003) suggest that the threat value of a stimulus is important in determining the extent to which it will capture and/or hold attention. Thus, potential differences in the threat value of stimuli may have resulted in differences in patterns of attentional bias to threat across studies.

Patients in this sample did not demonstrate attentional bias for physical threat words when they were presented subliminally, that is, outside of conscious awareness. This finding contrasts with the attentional bias toward pain words found in Boyer's study of patients with RAP (Boyer, 2002; Boyer et al., 2006). Studies examining methodological factors involved in eliciting attentional bias for threat in the laboratory

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suggest that the combination of physical threat stimuli and subliminal exposure level used in this study may have been ineffective in capturing the earliest moments in which patients' attention connects with physical threat. As reviewed above, one attentional bias study found that, in addition to individuals' anxiety levels, patterns of attentional orienting toward or away from threatening pictures was related to the pictures' threat intensity (Wilson & MacLeod, 2003). In addition, a study using an exogenous cueing task to examine attentional engagement and disengagement in healthy participants demonstrated that, at 100ms exposure levels, high trait anxious participants more strongly engaged their attention to threatening pictures and showed impaired disengagement from threatening pictures than low trait anxiety participants, whereas at 200ms and 500ms exposure levels, high trait anxious participants showed a stronger tendency to avoid threatening pictures (Koster, Crombez, Verschuere, Van Damme, & Wiersema, 2006). The threat level of pain words used in Boyer's study may be more effective in capturing the first moments in which patients with RAP attend toward physical threat. Additional research is necessary to identify the levels of subliminal exposure and/or threat intensity at which children with RAP demonstrate subliminal attentional bias to threat.

To investigate whether patients with RAP are biased to attend specifically toward physical threat or for any form of threat, attentional orienting was also investigated for social threat. At the subliminal level, when compared with the responses of Well children, patients with RAP showed significantly more bias toward social threat words. This finding may have been expected given the significant association of social competence to levels of somatic symptom reported by patients with RAP. For example, a prospective study investigating the effects of negative life events on patients' symptom

reports found that higher levels of negative events were associated with higher levels of somatic complaints for patients with low levels of social competence (Walker, Garber & Greene, 1994). Another study found that patients' perceived social, academic, and/or athletic competence played an important role in the relation of irritable bowel syndrome symptoms to functional disability. Specifically, for children with lower levels of perceived competence, more symptoms were related to more disability (Claar, Walker & Smith, 1999). To the extent that the social threat words used in the current study overlap with deficits in social, academic and athletic competence, patients with RAP may be expected to perceive these words as threatening and demonstrate more attentional bias toward them than Well participants.

In contrast, patients with RAP in this study did not differ from Well participants in their attentional orienting toward supraliminal social threat words. The difference in subliminal versus supraliminal orienting for social threat in patients with RAP may reflect a lower threshold for attentional capture of social threat or a difficulty disengaging from social threat that patients can strategically override when social threat reaches consciousness (e.g., Mogg & Bradley, 1998, 1999). The greater relevance of physical versus social threat words to chronic pain patients may at least partially explain why patients with RAP demonstrated bias toward physical threat words but not social threat at the supraliminal level (e.g., Pincus & Morely, 2001; see also Mathews & Klug, 1993; Riemann & McNally, 1995). Consistent with this finding of RAP patients' attentional bias toward subliminal social threat, adult patients with anxiety disorders demonstrate bias toward general forms of subliminal threat and bias toward supraliminal threat that is

associated with their personal concerns (e.g., MacLeod & Rutherford, 1992; Mogg et al., 1992).

In summary, when they could consciously read the words, patients with RAP demonstrated attentional bias toward physical threat, and did not demonstrate attentional bias for social threat. Attentional bias for physical threat was not found in Well children, suggesting that it is unique to chronic pediatric pain conditions. Furthermore, patients with RAP showed more attention toward social threat at the subliminal level than Well children. This pattern of attentional bias in patients with RAP is consistent with findings from the anxiety disorder literature demonstrating that patients with clinical anxiety disorders attend to general forms of threat at the subliminal exposure level and to threat that is specific to their domain of personal concern at the supraliminal level. Also, the pattern of attentional bias for physical threat found in this study is consistent with some of the findings from adult chronic pain studies, but is inconsistent with the only study examining pediatric patients with RAP to date, perhaps due to differences in threat stimuli.

Correlates of Attentional Bias for Threat

To understand patterns of attentional orienting to physical threat, the relation of attentional bias for physical and social threat to current affect, anxiety and somatic symptoms, and pain beliefs was investigated. First, based on Boyer's (2002) findings and the assumption that negative affect would prime threat bias, it was expected that attentional bias for threat would be greater for patients with higher levels of negative affect at the time of study participation. However, neither negative nor positive affect

was related to attentional bias for threat in the current study. This suggests that patients with RAP may have an attentional bias toward supraliminal physical threat and subliminal social threat irrespective of current affect. To more explicitly investigate whether current affect is relevant for attentional bias for threat, laboratory tasks should be used to manipulate mood and observe its effect on attentional bias (Boyer, 2002).

Contrary to predictions, neither GI nor non-GI symptoms reported at the time of the task were related to attentional bias for physical threat for patients with RAP. Unexpectedly,, levels of non-GI symptoms were inversely related to supraliminal social threat bias. It is possible that although school children rated threat words in both categories as equally negative, patients with RAP perceive social threat words as more distressing than physical threat words and that they therefore are more likely to trigger somatic symptoms (Boyer, 2002; Boyer et al., 2006). If so, patients' attentional avoidance of social threat words on the computer screen may be effective in managing their social-related distress, but result in increased levels of somatic symptoms. It is also possible that patients with RAP who avoided supraliminal social threat had more attentional reserves to notice higher levels of somatic symptoms, whereas patients who attended toward social threat were less apt to notice and report somatic symptoms. This explanation appears less plausible given findings from a daily diary study in which patients with RAP reported more somatic symptoms in response to social and other stressors than healthy peers (Walker, Garber, Smith, Van Slyke, & Claar, 2001). Also, analysis of the most concerning stressor reported by these patients indicated that pain and somatic symptoms are more significant concerns of patients than social and other stressors (Lipani et al., 2004). Nonetheless, patients with RAP may be unable to

recognize and report the degree to which they are concerned with social stressors. In summary, findings showed an inverse relation of supraliminal social threat bias to current non-GI symptoms, and attentional bias toward supraliminal physical threat regardless of current GI and non-GI symptoms.

Regarding patients' trait anxiety, attentional bias for physical threat words was related only to child-reported physical anxiety symptoms. Contrary to predictions, this relation was negative. Thus, when the words were presented within awareness, avoidance of physical threat was related to higher trait levels of physical anxiety symptoms, and attention toward physical threat was related to lower trait levels of physical anxiety symptoms. This pattern is consistent with models of coping responses to pain and stress in which efforts that involve attention directed toward pain, such as cognitive restructuring, are associated with less anxiety (e.g., Suls & Fletcher, 1985; Thomsen et al., 2002). The lower levels of anxiety may be the result of desensitization or habituation to the noxious sensations of pain (Kabat-Zinn, 1982); in contrast, avoidance of physical threat would interfere with desensitization and result in greater anxiety levels (Asmundson et al., 1999). Attentional bias toward threat such as pain may act as an anxiety regulatory mechanism by fostering the early detection of distress-promoting experiences (e.g., Mathews and Mackintosh, 1998; Mogg & Bradley, 1998, 1999).

The relation of greater physical threat attentional bias to lower levels of physical anxiety symptoms in patients with RAP contrasts with positive relations expected based on studies from the chronic pain and anxiety disorder literatures. Several studies using a Stroop task demonstrated a positive relation of anxiety symptoms to color-naming interference effects for pain words in adult pain patients (Snider et al., 2000; Pincus et al.,

1998) or social threat words in adults with an anxiety disorder (Mogg et al., 1992). Using a dot probe task, a positive relation of anxiety symptoms to bias for pain words was found for pain patients (Asmundson et al., 2005; Boyer, et al., 2006), and for social threat words in a study of anxious adults (Mogg, Mathews & Weinman, 1989). However, other studies of adult pain patients have not found a relation of anxiety symptoms to color-naming interference effects of pain words (Crombez et al., 2000) or to attentional bias for pain words (Asmundson et al., 1997; Roelofs, Peters, Fassaert, Vlaeyen, 2005). Furthermore, studies of anxious children have found inconsistent relations of anxiety severity to dot probe or Stroop task responses to threat words, with two studies failing to demonstrate a significant association in children with an anxiety disorder (Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999; Taghavi, Dalgleish, Moradi, Neshat-Doost, & Yule, 2003) and one study showing a negative relation of anxiety levels to attentional bias for threat in children with high levels of test anxiety (Vasey et al., 1996). Thus, the relation of anxiety symptom severity to attentional interference or bias to physical threat words has not been well established, and future attentional studies of patients with chronic pain are needed to clarify the relation of anxiety symptoms to attentional bias for physical threat.

Despite the inconsistent research to date on the relation of physical threat attentional bias to anxiety, the negative relation found in this study could be viewed as support for the theory that physical threat attentional bias is specific to chronic pediatric pain and not due to general anxiety alone. First, supraliminal attentional bias for physical threat was not related to other forms of child-reported anxiety (e.g., social anxiety). In addition, attentional bias toward supraliminal social threat was inversely related to

parent-reported internalizing symptoms and social problems, and not physical anxiety symptoms, demonstrating specificity of relations of bias to anxiety symptoms within the physical and social threat domains. This pattern of associations between attentional bias for threat and related anxiety symptoms and its divergence from results of studies of attentional bias in anxiety disorders provide preliminary support for the specificity of bias for physical threat in patients with RAP. Previous investigations of the relation of anxiety to threat bias in chronic pain populations may have yielded mixed results due to the focus on general anxiety symptoms. Child-report of physical anxiety symptoms, which may be more relevant to chronic pain disorders than general anxiety symptoms, must be included in future attentional bias studies in order to investigate this possibility.

The lack of association found for attentional bias to other forms of child-reported anxiety symptoms (i.e., social anxiety and separation anxiety) in patients with RAP contrasts with the significant relations found for Well children. Specifically, Well children demonstrated low but significant negative associations of supraliminal and subliminal social threat attentional bias to social and separation anxiety symptoms, respectively. These findings provide added support for the relation of results from this laboratory measure of attentional bias for threat to well-validated questionnaire measures of anxiety. Also, the difference between patients with RAP and Well participants in the relation of physical versus other anxiety symptoms to attentional bias for physical versus social threat provides support for the theory that attentional orienting for physical threat operates differently in patients with RAP than pain-free children.

Finally, attentional bias for physical threat was negatively related to the degree to which patients perceived their pain condition to be serious. That is, patients who

believed their chronic pain condition to be more serious demonstrated greater attentional avoidance of supraliminally presented physical threat, and patients who believed their condition to be less serious demonstrated greater attention toward supraliminally presented physical threat. The association between physical threat attentional bias and pain severity beliefs is consistent with theories (e.g., Eccleston & Crombez, 1999) and preliminary evidence (Wilson & MacLeod, 2003) that threat is important in determining the extent to which pain attracts attention. At first, the direction of this relation appears different from the relation proposed by Eccleston and Crombez, who suggest that greater perceived pain threat is related to greater attentional interruption by pain. However, it is possible that, in the context of the dot probe task, participants who believe that their illness is more serious perceived more threat in the physical threat words, which may have facilitated attentional interruption by physical threat words and triggered subsequent avoidance of it in an attempt to manage related distress. Conversely, patients who believe their illness to be less serious may perceive less threat in physical threat words and therefore experience less or later interruption in response to viewing them on the screen. The lower threat value may not have triggered attentional avoidance of these words. Additional research involving pain beliefs, perception of physical threat, attentional orienting, and coping styles (e.g., tendency to respond to pain and stress with avoidance) is needed to investigate these possibilities and their implications for patients' experience of RAP.

Attentional bias to subliminally presented physical threat words was not related to anxiety or pain threat beliefs for patients with RAP. This contrasts with expectations that subliminal attention to physical threat would be related to anxiety and pain threat

perception, but is consistent with other investigations of subliminal pain attentional bias and anxiety (Boyer, 2002; Boyer et al., 2006; Snider et al., 2000). This area requires further research; other pain-related words and/or different subliminal exposure levels may be more appropriate for identifying relations of subliminal threat bias to pain beliefs and psychological distress in children with RAP.

In addition, neither subliminal nor supraliminal physical threat attentional bias was related to parent-reported frequency of somatic symptoms on the CBCL. Few published studies have measured the correlation of pain severity to attentional bias for physical threat, and those that have examined this relation have demonstrated mixed results. Specifically, Boyer and colleagues (2006) found a positive relation between attention toward pain words and pain, and Crombez and colleagues (2000) found a positive relation between color-naming latency of Stroop task pain words and pain severity. Conversely, neither Pincus and colleagues (1998) nor Snider and colleagues (2000) found a relation between color-naming latency of Stroop task pain words and pain severity. Additional research into the relations of attentional bias for physical threat to pain experience is needed to clarify these associations. Future research should specifically assess the frequency and intensity of patients' pain episodes to understand the implications of physical threat attentional bias for patients' pain experiences.

The relation of attentional bias to temporal and demographic features of the study and its participants were examined to investigate alternative explanations of threat bias and explore developmental and gender trends in attentional bias. Results indicated that age and gender were not related to attentional bias scores for patients with RAP. Similarly, Boyer and colleagues (Boyer, 2002; Boyer et al., 2006) did not find a relation

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between attentional bias and patients' demographic characteristics. Nonetheless, future studies should continue to investigate potential relations of gender and age to attentional bias for threat to discern whether this finding will be replicated in other samples.

For the RAP group, attention toward subliminal physical threat and a trend for attention toward subliminal social threat were inversely related to the number of days between patients' initial clinic visits and their participation in the dot probe task. Thus, when words were presented outside of conscious awareness, patients who completed the task closer in time to their clinic appointment demonstrated greater attentional bias toward threat words than patients for whom more time had passed between the dot probe task and their clinic appointment. This relation was not observed in Boyer's study of patients with RAP (Boyer, 2002; Boyer et al., 2006). As discussed above, pediatric and adult patients with clinical anxiety disorders show greater attention toward threat than non-anxious individuals (e.g., MacCleod et al., 1986). For children with RAP, medical examinations by a pediatric gastroenterologist may be associated with heightened anxiety, and this anxiety may be related to greater attention toward subliminal threat. Patients in this study were informed at the time of their initial clinic appointment or shortly afterward that there was no organic cause for their pain. This information may have been associated with a reduction in anxiety and accompanying decrease in attentional bias toward threat over time.

In addition, completion of the dot probe task at earlier hours of the day was associated with greater attention toward supraliminal physical threat words for patients with RAP. This association also was reported in Boyer's study (2002). Clinical observations of RAP suggest that patients experience more abdominal distress during the

morning than the afternoon or evening (Walker & Johnson, 2004). Patients' bias toward physical threat at earlier hours may be related to the greater frequency of abdominal pain episodes during these hours. Additional research is necessary to understand the association between bias for supraliminal physical threat words and time of task completion, which was replicated across studies despite other differences in outcomes.

Conclusions, Limitations and Future Directions

This study tested components of a model that proposes a relation among pain severity beliefs, attentional orienting toward physical threat, and the frequency and severity of pain episodes. Results showed that patients with RAP demonstrated bias toward physical threat, and that more serious pain beliefs were related to greater attention toward physical threat. In contrast, support was not found for the hypothesized relation of greater attentional bias to more pain and somatic symptoms. This may be due to the lack of child-report measures of the frequency and severity of patients' pain and somatic symptoms. Pain information was not obtained from children in an attempt to avoid priming their attention toward physical threat words on the dot probe task or toward greater symptom reporting after they read physical threat words during the task (cf. Lundh & Czyzykow-Czarnocka, 2001). Future studies should obtain patient ratings of pain frequency and severity on a different day than the study or following a distractor task after the study in order to supplement parent-reported measures of pain and somatic symptoms. Symptoms also could be assessed several weeks to months following the dot probe task to investigate whether pain-related attentional bias predicts maintenance of pain and somatic symptoms.

Also, assessment of patients' coping strategies and other responses to pain and pain-related disability would provide a more comprehensive picture of the context in which patients experience pain episodes and how attentional bias is related to disability. Researchers have suggested that biases to attend toward pain may reflect children's lack of abilities to shift attention away from stressors and toward effective coping strategies for dealing with it, resulting in higher levels of pain and disability (e.g., Compas & Boyer, 2001; Zeltzer, Bursch, et al., 1997). However, in this study, biases toward physical threat were related to lower levels of physical anxiety symptoms, suggesting that attentional bias toward pain may be adaptive. Consistent with the negative relation of physical threat bias to physical anxiety symptoms, a study of women with breast cancer found that greater attention toward cancer-related words was related to lower levels of emotional distress (Glinder, Beckjord, Kaiser, & Compas, 2006). The authors suggested that selective attention to threat may represent a first step in seeking out information that can be used in a more cognitively complex form of coping, such as acceptance of one's situation or cognitive restructuring. Additional research addressing coping and disability will help identify the nature and long-term implications of attentional bias to physical threat in RAP, and will help guide treatment.

As a group, patients with RAP demonstrated attentional bias toward physical threat, yet some patients demonstrated a tendency to avoid physical threat. The relation of attentional avoidance of physical threat to higher levels of physical anxiety symptoms and beliefs that their pain condition is more serious suggests that some patients with RAP could benefit from treatment that addresses attentional orienting for physical threat. The relation of attention toward physical threat to lower levels of physical anxiety symptoms

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and less severe beliefs regarding their chronic pain condition suggests that attentional bias toward physical threat appears to be related to more accurate and helpful cognitions and less distress. Future research must address pain outcomes and disability associated with attentional bias toward physical threat before conclusions about bias toward physical threat can be made.

In addition, the context of attentional bias should be investigated with respect to stress. A daily diary study found that patients with RAP, when compared with pain-free children, responded to stressors with equal levels of negative affect but greater levels of somatization symptoms (Walker et al., 2001). Thus, patients with RAP may show more attentional bias toward physical threat words when under stressful conditions than Well children or than they would in low stress conditions. This concept is currently under investigation using the dot probe task after a stress-inducing activity (Walker, et al., 2001).

The current findings regarding attentional bias to physical threat in patients with RAP provide support for theories suggesting that RAP is characterized by a attentional bias toward pain and difficulty with disengaging attention from pain. Investigations of attentional bias to physical threat in disorders involving abdominal pain related to biological pathology (e.g., Crohn's disease) as well as other chronic pain disorders (e.g., sickle cell disease pain) would address questions regarding whether attentional bias for physical threat is specific to functional abdominal pain or whether the etiologies of chronic pain and attentional bias for physical threat are unrelated. Furthermore, examination of attentional bias in groups of patients with other pediatric illness and disease (e.g., diabetes, cystic fibrosis) would provide insight into whether the differences

between patients with RAP and Well participants observed in this study are due to chronic pain per se or to the associated features of chronic illness in children (Pincus & Morley, 2001).

The predominantly cross-sectional nature of this study limits the conclusions that can be drawn regarding the development of attentional bias and causes of functional RAP. In contrast, one prospective study of a clinical population demonstrated that attentional bias to threat was related to later development of emotional distress following a cancer diagnosis (MacLeod & Hagan, 1992), providing support for theories suggesting that attentional bias to threat contributes to development of somatic or emotional difficulties. Despite the lack of information addressing causality in the current study, results are consistent with the theory that children with RAP demonstrate unique biases for pain-related information (Zeltzer, Bursch, et al., 1997; Zeltzer, Bush, et al., 1997). To address questions regarding causality, future studies could examine bias for physical threat in children presenting to their primary care physician with abdominal pain complaints and investigate whether attentional bias for physical threat predicts symptom maintenance over time.

While modifications to threat stimuli and some procedures were made in this study to improve the design over other attentional bias studies, these changes add to the heterogeneity of attentional bias study methodologies and prevent clear comparisons of findings across studies. Use of the dot probe task to measure attentional bias to physical threat improves upon modified Stroop tasks in that attentional engagement toward threat versus avoidance of threat can be assessed. However, it cannot be determined whether the attentional engagement with physical threat observed in this study reflects facilitated

attentional engagement to threat or difficulties disengaging attention from threat (e.g., Koster et al., 2006). Future research should attempt to replicate this study's findings as well as consider using other paradigms that address engagement and disengagement features of attentional orienting, such as an exogenous cueing task (e.g., Koster et al., 2006).

Social threat words were used in this study in an attempt to test whether patients with RAP are biased only to attend to physical threat or to any type of threatening information. However, social threat may be as relevant as physical threat for patients with RAP, who often miss school and other opportunities to develop age-appropriate relationships with peers, and for whom lower levels of social competence have been shown to be related to higher levels of symptom complaints (Walker et al., 1994). In fact, this study showed that patients demonstrated more attentional bias toward subliminal social threat than Well participants. The extent of subliminal social threat attentional bias was not significantly different from a neutral attentional stance, suggesting that this bias is less robust than attentional bias demonstrated by patients with RAP for supraliminal physical threat. Nonetheless, future investigations of the specificity of attentional bias for physical threat in this population should include another comparison category of negative words that are less relevant to RAP, such as accident-related words (Boyer, 2002).

Another limitation of the study concerns the neutral words that were matched with threat words. These words were not from a particular category, and included different parts of speech (see Table 1). In an attentional bias study using the Stroop task, Mogg and colleagues found that, compared to non-anxious adults, anxious adults were slower in

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color naming uncategorized versus categorized neutral words in the supraliminal condition (Mogg et al., 1993). Thus, attentional bias patterns in this study may reflect the tendency for participants to attend toward category-relevant words, in this case, supraliminal physical threat words. However, bias toward categorized words was not found in the supraliminal social threat condition, making the possibility that attentional bias patterns observed in this study reflect participants' tendency to attend toward category-relevant words less plausible. Nonetheless, the effect cannot be ruled out without further investigation in children using the dot probe task.

Findings from this study do not include data from children ages eight and nine, whose attentional bias scores appeared irregular when compared with scores from children ten and older. Kindt and Van Den Hout (2001) propose that information processing biases in childhood are dependent on a child's ability to inhibit attention to threat. In their review of attentional bias studies in children with varying levels of anxiety, they suggest that attentional bias toward threat is prevalent in younger children regardless of anxiety levels, and that the ability to inhibit attention toward threat develops at approximately age ten in non-anxious children. Thus, younger patients with RAP may not differ from pain-free children in their attentional orienting toward physical threat. If so, this would suggest that attentional bias for physical threat does not play a role in the development of RAP, at least in children younger than ten, and may instead develop as a consequence of RAP. Additional prospective research with young children with RAP is necessary to explore this issue further.

In conclusion, this study provides evidence to support the theory that patients with RAP are biased to attend toward physical threat, and that this attentional bias is specific

to the experience of chronic pain. Attentional bias toward physical threat words appears adaptive in that it was related to lower levels of physical anxiety symptoms and to beliefs that their chronic pain condition was less serious. Parental report of the frequency of patients' pain and somatic symptoms was not related to attentional bias toward physical threat; future studies should include patient report of pain, somatic symptoms and disability to further investigate the implications of attentional bias toward physical threat. The current findings require replication and further investigation particularly given inconsistencies in the attentional bias and chronic pain literature to date. Furthermore, prospective studies are needed to investigate whether attentional bias contributes to the development of RAP, and the long-term implications it may have for continued pain, disability and related distress.

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