Attentional Biases to Pain and Social Threat in Children with Recurrent Abdominal Pain

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Objectives To test whether children with recurrent abdominal pain (RAP) exhibit subliminal (nonconscious) and supraliminal (conscious) attentional biases to pain-related words, and to determine correlates of these biases. Previous research indicates that individuals attend to disorder-relevant threat words, and in this study, attentional biases to disorder-relevant threat (pain), alternative threat (social threat), and neutral words were compared. **Methods** Participants were 59 children with RAP who completed a computer-based attentional bias task. Participants and their parents also completed questionnaires measuring pain, somatic complaints, anxiety/ depression, and body vigilance. **Results** Children with RAP showed attentional biases toward subliminal pain-related words and attentional biases away from supraliminal pain-related words. Participants' attentional biases to social threat-related words were marginally significant and also reflected subliminal attention and supraliminal avoidance. Attentional biases were related to parent and child reports of pain, body vigilance, and anxiety/ depression. **Conclusions** Children with RAP show nonconscious attention to and conscious avoidance of threat-related words. Their attentional biases relate to individual differences in symptom severity. Implications for models of pediatric pain and future studies are discussed.

Key words attention; attentional bias; recurrent abdominal pain.

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Several models of pediatric pain have emphasized the role of attention in the development and maintenance of chronic pain (Compas & Boyer, 2001; Walker, 1999; Zeltzer, Bush, Chen, & Riveral, 1997). For example, in a presentation of the psychobiological aspects of pediatric pain, Zeltzer and colleagues propose that children with poor attention regulation will be at a particular disadvantage when suffering from acute pain, because pain will disproportionately draw their attentional focus (Zeltzer et al., 1997). This focus on pain will lead to anxiety, pain fear, and in turn more pain focus, which will become a self-perpetuating cycle and lead to chronic pain. In a model of recurrent abdominal pain (RAP), Walker (1999) highlights this role of pain focus in the development of heightened pain perception and argues that this may be one of the critical factors that characterize children with pain who are vulnerable to adopting a chronic sick role. Compas and Boyer (2001) suggest that children who focus their attention on pain may not only experience greater pain perception, but also have fewer attentional resources available to engage in adaptive coping strategies.

Emerging evidence has shown that subjective reports of focusing attention on pain are related to pain sensitivity and pain-related distress in children. For example, a recent study of parents' reports of children with RAP showed that children whose responses to pain included intrusive thoughts and ruminations about pain had higher levels of anxiety/depression symptoms and overall somatic complaints (Thomsen et al., 2002).

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Another study of children with RAP found that those who self-reported coping by focusing attention on pain (e.g., holding or rubbing the stomach) had higher levels of pain and somatization (Walker, Smith, Garber, & Van Slyke, 1997). Similarly, among children with sickle cell disease, parents' reports of children's overall suffering was associated with the children's focusing on pain-related fear and anger as well as catastrophic thinking (Gil, Williams, Thompson, & Kinney, 1991).

Despite these significant findings, the evidence that attention to pain affects pain and pain-related distress in children is based on parent and child-reported questionnaires, which while important, are subject to several sources of error, including recall biases. To better understand how attention relates to pain, studies that track *in vivo* how children attend to pain or pain-related reminders on a moment-by-moment basis and monitor how this is related to pain, distress, and functioning are needed. Some studies have begun to use these methods with adults, including a laboratory study of adults with chronic pain that found that participants who had difficulty shifting attention away from pain had higher levels of pain (Eccleston, 1995).

In order to assess how children with recurrent pain attend to pain, this study draws on the methods used to study biases in attention. These laboratory-based methods have been used to assess how individuals with certain emotional disorders pay attention to disorder-related cues, typically in the form of words or pictures, compared to cues unrelated to their disorders. Researchers propose that attentional biases to disorder-related cues reflect hypervigilance to sources of perceived threat, such that even words and pictures associated with an emotional disorder are appraised as threatening. This proposal is consistent with current models of pain, including those described above, which hypothesize that attention to pain is in part due to the appraisal of pain as a source of threat (Eccleston & Crombez, 1999; Zeltzer et al., 1997). Attentional biases have been shown to relate to other measures of psychopathology (e.g., self-report measures), appear at both subliminal (nonconscious) and supraliminal (conscious) levels of awareness, and diminish once a disorder has been adequately treated (Mathews, Mogg, Kentish, & Eysenck, 1995; Mogg, Bradley, & Williams, 1995). Attentional biases have been found in various populations, including adults with anxiety disorders (e.g., MacLeod, Mathews, & Tata, 1986), chronic pain (e.g., Pearce & Morley, 1989), depression (e.g., Gotlib & McCann, 1984), eating concerns (e.g., Seddon & Waller, 2000), breast cancer (e.g., Glinder, Compas, & Kaiser, 2005), and children with anxiety (e.g., Vasey, Daleiden, Williams, & Brown, 1995).

In the current study, we tested how children with RAP attended to pain-related words by using an attentional bias paradigm. RAP is a paroxysmal, periumbilical, nonradiating episodic type of pain that significantly interferes with normal functioning (Colletti, 1998). The pain must occur at least once a month for 3 months to meet traditional criteria (Apley, 1975). RAP is the most common type of recurrent pediatric pain, experienced by 10–30% of school-aged children. Several studies have found that children with RAP have high rates of anxiety (e.g., Hodges, Kline, Barbero, & Woodruff, 1985; Walker, Garber, & Greene, 1993). This characteristic provided additional support for testing an attentional bias paradigm, because attentional biases appear especially robust in anxious individuals (Williams, Mathews, & MacLeod, 1996).

Specifically, we examined participants' attention allocation when simultaneously shown both pain and nonpain-related neutral words, and predicted that participants would show attentional biases to pain. In addition, to understand whether these hypothesized attentional biases reflected biases to threat words in general or biases specific to pain words, we compared participants' attention to a nonpain source of threat (social threat) and neutral words. We predicted that participants would not show attentional biases to social threat words at a conscious level (see below.) As a corollary to this hypothesis, we predicted that attentional biases to pain words would be greater than to social threat words. We based these hypotheses on the pediatric pain models described above that highlight the specific role of pain-focused attention in children with chronic pain.

In addition to these hypotheses, we tested whether participants showed attentional biases to pain at both conscious and nonconscious levels of awareness. Previous research suggests that attention is not a unitary construct, but rather includes subliminal (nonconscious, automatic) and supraliminal (conscious, controlled) components (Shiffrin & Schneider, 1977). These two attentional systems are distinct: the subliminal system scans involuntarily and widely for any possible threat, whereas the supraliminal system deliberately selects certain stimuli to focus on and respond to (Compas & Boyer, 2001). Some previous attentional bias studies have demonstrated that at a subliminal level, individuals with emotional disorders attend to general threat versus neutral cues, but do not show a preference for disorder-relevant threat cues (e.g., MacLeod & Rutherford, 1992). In addition, studies of supraliminal attentional biases generally show that individuals attend to concern-specific words (e.g., Mathews & MacLeod, 1985). We predicted

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that children with RAP would show this pattern, namely attentional biases specific to pain words at a supraliminal level, and attentional biases to general threat (i.e., both pain and social threat vs. neutral words) at a subliminal level.

Finally, we predicted that laboratory-measured attention to pain would relate to higher levels of parent and self-reported questionnaire measures of pain, anxiety/depression, somatic complaints, and body vigilance (similar to somatosensory amplification, see Zeltzer et al., 1997). Because this study represented the first attempt to measure attentional biases in a RAP sample, subliminal attentional biases in children, and subliminal attentional biases in a chronic pain sample, a within-subjects design was used to devote adequate attention to these areas, similar to several in-depth attentional bias investigations in adult pain samples (e.g., Crombez, Eccleston, Baeyens, Van Houdenhove, & Van den Broeck, 1999).

Method

Participants

Participants were 59 children and adolescents with RAP who had experienced at least one episode of abdominal pain per month in each of the past 3 months, resulting in significant impairment. All participants were recruited from a pediatric gastroenterology practice at Fletcher Allen Health Care in Burlington, Vermont. The mean age of the sample was 12.59 years (*SD* = 2.4), range 9–17 years, and consisted of 33 girls (55.9%) and 26 boys (44.1%). The mean occupational status of their parents, based on the Hollingshead occupational scores that ranges from one to nine (Hollingshead, 1975), was 5.9 (*SD* = 2.23), or that of technicians, semiprofessionals and small business owners. The sample was 93% Caucasian (55 children), with two children of "mixed" non-White ethnicity (also, two families chose not to report ethnicity information). This ethnic distribution is representative of the demographic characteristics of Vermont and northern New York State from which this sample was drawn.

Medical chart reviews revealed that 37 children (62.7%) had a functional pain diagnosis, 18 children (30.5%) had an organic pain diagnosis, and the remaining four children (6.8%) had an unknown diagnosis (i.e., they did not return to the clinic for diagnostic tests). Functional diagnoses of RAP included functional dyspepsia, irritable bowel syndrome, and functional abdominal pain not otherwise specified. Organic diagnoses of RAP included hernia, esophagitis, lactose malabsorption, Crohn's disease, and inflammatory bowel disease. At their initial clinic visit to the pediatric gastroenterologist, participants reported that they had experienced RAP for just over 2 years on average (*M* = 24.91 months, *SD* = 25.29, *Mdn* = 13.5 months, range = 3–120 months). Participants also reported experiencing an average of 3.98 physical symptoms (*SD* = 2.11), such as pain, diarrhea, headaches, and vomiting.

Procedure

Eligible children with RAP and their parents learned of the study at their initial clinic visit or in letters if they had participated in research in the past and continued to meet RAP criteria. Interested families received detailed information about the study and informed consent was obtained. The study was approved by the Institutional Review Board of the University of Vermont. Upon arrival to the experimental session, the study was reviewed and children were encouraged to ask questions about the lab to help them to feel comfortable. Parents were then asked to move to a waiting room, because it was expected that their presence might influence task performance.

Measures

Cognitive Attentional Bias Task

Children's attentional biases were measured using a dot probe detection task, which has been used widely in research with adults, and more recently in research with children (e.g., Vasey, 1996). Threat words involved in this task were chosen from two categories: the disorder-related threat category consisted of pain words (e.g., cramp, ache), and the comparison threat category consisted of social threat words (e.g., loser, teased). The word selection procedure was based closely on those of Vasey and colleagues (1995, 1996) and other dot probe researchers. See Table I for the list of 64 social threat and pain words, along with matched neutral (household) words.

Initially, experimenters generated a list of potential threat words, drawing from other attentional bias tasks and pain questionnaires. Several undergraduate psychology students, who were naïve as to the purpose of the words, rated the words as either pain related or social-threat related and on a 7-point Likert scale for emotional valence from –3 (extremely negative) to 3 (extremely positive) with 0 = neither negative nor positive. Threat words were chosen only if all raters placed them in the same threat category, and only if they received an average negative valence rating between –1.75 and –3.

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Table I. Social Threat, Pain, and Matched Household (Neutral) Words in the Dot Probe Task

Social threat/household words	Pain/household words
Dumb—pets	Disease—bedroom
Unwanted—stairway	Unbearable—dinnerware
Coward—stairs	Piercing—bookends
Bullied—bathtub	Pain—door
Cheat—chair	Suffer—gutter
Idiot—mixer	Injure—hammer
Dummy—knife	Puncture—loveseat
Lonesome—upstairs	Accident—saucepan
Teased—washer	Tummyache—newspaper
Crybaby—kitchen	Fever—plant
Sissy—plate	Bloody—parlor
Misfit—mantle	Gash—iron
Deserted—linoleum	Wound—quilt
Loser—office	Bellyache—whirlpool
Tattletale—flowerpots	Stomachache—screwdriver
Goofy—piano	Emergency—fireplace
Disliked—bookcase	Headache—scissors
Dunce—tiles	Ill—pot
Dope—rugs	Sick—sink
Argue—phone	Hurt—yard
Clumsy—hamper	Ouch—yarn
Alone—table	Burn—lamp
Moron—patio	Sting—grill
Chicken—showers	Bleed—dryer
Awkward—cabinet	Throwup—dresser
Jerk—beds	Gassy—hinge
Stupid—rocker	Injection—washstand
Fool—cars	Ache—gate
Lonely—bureau	Cramp—glass
Unpopular—furniture	Pinch—house
Shame—plant	Booboo—pantry
Embarrass—radiators	Stab—fork

Each threat word was paired with a neutral, non-threat word of the same reading level and same length.[1] Raters evaluated test words as neutral if they had an average mean threat rating between –1 and 1 on the same emotional valence Likert scale described above. In addition, neutral words were selected to correspond to a household item category (e.g., table, couch) to reduce the likelihood that biases to threat words might simply reflect category priming. A total of 32 social threat words, 32 pain words, and 64 matched household words were chosen. In addition to these 64 word pairs, 32 length-matched pairs of noncategorized neutral filler words were chosen to control for response biases that might result from the expectation of negative words on each trial. Emotional valence ratings for pain, social threat, and neutral words were significantly different, $F(2, 126) = 1396.3$, $p < .001$. A Scheffe's test revealed that the mean emotional valence ratings for pain words ($M = -2.49$) and social threat words ($M = -2.50$) were not significantly different from each other, and that both were significantly different from the neutral word ratings ($M = 0.04$).

Words for the dot probe task were presented by using a Dell Optiplex Gxa computer and a 15-inch monitor. The E-Prime computer software program (Psychology Software Tools, 2001) controlled the presentation of the words and recorded response latency and accuracy. Seating was adjusted for each participant so that the words appeared at eye level, and all participants sat equidistant 60 centimeters (cm) from the screen. The lighting in the experiment room was dimmed to a preset luminescence.

On each dot probe trial, a fixation mark appeared in the center of the screen (a small white addition symbol, "+") for 1000 milliseconds (ms) (1 second). When the fixation spot disappeared, one of the 96 word pairs was randomly selected by the computer and appeared on the screen. All words appeared in white script at the center a black screen, separated vertically by 3 cm. After the words disappeared, the dot probe (a small white dot) appeared in the same position as either the upper or lower word. Once the probe appeared, participants were instructed to press one of two keyboard buttons (labeled "upper" or "lower") as quickly and accurately as possible to indicate which word they thought the dot probe replaced. Following Vasey's (1996) dot probe protocol, word pairs in the supraliminal exposure condition appeared on the screen for 1250 ms.) For the subliminal exposure condition, words were presented for 20 ms., followed by a pair of length-matched nonsensical letter strings made up of consonants (e.g., GTYHC-SHFTQ) that

[1]The reading level of each threat and neutral word was established using an encyclopedia of words rigorously tested for reading level (Dale & O'Rourke, 1981). Of the 32 pain words, 25 were at 4th grade level and 7 were at 6th grade level. Of the neutral words matched with these pain words, 25 were at 4th grade level and 7 were at 6th grade level. Of the 32 social threat words, 25 were at 4th grade level and 7 were at 6th grade level. Of the 32 neutral words matched with these social threat words, 24 were at 4th grade level and 8 were at 6th grade level. Based on our selection procedures, if a child did not have the reading level to understand a particular social threat word, they would also not have the reading level to understand the neutral word it was matched with. This should have prevented within-trial biases that could reflect differences in the words' reading level rather than the words' threat value. Furthermore, there were exactly as many social threat words and pain words at 4th and 6th grade reading levels. This should have prevented biases due to reading level, rather than biases reflecting attention to different categories of threat words. Finally, the average word length of the social threat words was 6.13 letters and the average word length of the pain words was 6.15 letters, so the attentional biases we found were presumably not a reflection of attention to words of different length.

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appeared for 1230 ms. Following the practice trials, each participant was exposed to 192 distinct trials, evenly divided between supraliminal and subliminal exposure conditions.

The computer recorded the rate and accuracy of participants' responses on the keyboard buttons corresponding to dot probe position during all tasks. The recorded latencies served as the main dependent variables and measures of selective attention in this study. An attentional bias *toward* threat words was indicated if there were overall shorter response latencies on trials when dot probes replaced threat words in the threat-neutral word pairs and overall longer response latencies on trials when dot probes replaced neutral words in the threat-neutral word pairs. An attentional bias *away* from threat words (i.e., avoidance) was indicated if the reverse pattern appeared; namely, longer response latencies on trials when dot probes replaced threat words and shorter response latencies on trials when dot probes replaced neutral words.

To ensure that words in the subliminal exposure condition were presented outside conscious awareness, a validity check was conducted. This lexical decision task required that participants decide whether a real word or a nonsense word was presented during a subliminal trial to determine whether or not participants could read the content of words at 20 ms. A 50% overall accuracy rate on this validity task would indicate that participants were guessing and/or unable to read the content of the words, and therefore unable to assess the subliminal words.[2] In this task, two words were randomly selected by the computer and presented on the screen for 20 ms. These words were either real words (e.g., house) or nonsense words (e.g., "blorky"). Following each subliminal word presentation, two length-matched letter strings made up of consonants (e.g., HYTSQW-HYTSQW) replaced these words and remained on the screen for 1230 ms. Participants were asked to press a key indicating whether or not the words presented before the letter strings were real words or not. The task included social threat, pain, and neutral words, as well as filler words. Before and after the dot probe task, participants completed several measures, described below.

[2]Some dot probe experiments include a presence/absence task to test whether or not participants can see if a subliminal word (either nonsense or real) has been presented prior to a nonsense word string (e.g., Mogg et al., 1995). Prior experiments in our lab have shown that participants are able to detect the presence or absence of subliminal words at a 77% accuracy rate, although they could not tell the content of the words in lexical decision tasks, as demonstrated by an accuracy rating of 47% (Glinder, Compas, & Kaiser, 2005). Given that the presence/absence task did not achieve its intended purpose in past experiments, we chose not to use the presence-absence task in this experiment, and instead relied only on the lexical decision task.

Abdominal Pain

Participants and their parents completed the Abdominal Pain Index (API; Walker, Smith, Garber, & Van Slyke, 1997) following the dot probe task. The API is a five-item measure, with self-report and parent-report versions, that assesses information about abdominal pain intensity, frequency, and duration over the past 2 weeks. Pain ratings are measured on Likert scales. For this study, a summary score was calculated, composed of standardized scores (z-scores) for all items, reflecting abdominal pain over the past 2 weeks. In this sample, for the parent API, $\alpha = .84$, and for the child API, $\alpha = .83$.

Body Vigilance

Participants also completed the Body Vigilance Scale (BVS; Schmidt, Lerew, & Trakowski, 1997) following the dot probe. The BVS is a four-item self-report inventory designed to assess attentional focus to internal bodily sensations. Three questions measure attentional focus, sensitivity to changes in bodily sensations, and time spent attending to bodily sensations. The fourth question assesses the degree to which participants pay attention to 15 specific physical sensations, such as upset stomach and nausea. The questionnaire was slightly modified to correspond to the reading level of the youngest children in the study. The BVS has good reliability and validity (Schmidt et al., 1997). The BVS yields a single index score, which results from weighting the four items to account for different scales, and summing them. In the current study, $\alpha = .77$.

Anxiety/Depression and Somatic Complaints

The parents of children with RAP completed the Child Behavior Checklist (CBCL; Achenbach, 1991), a measure that includes 118 problem behaviors rated on a 3-point scale ranging from "not true" to "often or always true." Scores from the anxiety/depression syndrome scale were used to measure children's distress, and scores from the somatic complaints syndrome scale were used to measure overall somatic problems. Reliability and validity of the CBCL are well established (Achenbach, 1991).

Results

Attentional Bias

Because of technical difficulties in administration of the task, dot probe responses for two participants were not recorded. Thus, attentional bias data for 57 participants were available for analyses. Standard procedures were

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followed to remove inaccurate and outlying response latency scores.[3]

The average response accuracy for the trials of the lexical decision task was 52.00%, which did not significantly differ from a chance response accuracy of 50.00%, $t(1025) = -1.31$, $p > .05$. In addition, no single participant's responses fell outside limits that could be expected by chance. Therefore, all response latency data in the subliminal condition were used in the attentional bias analyses and are presumed to reflect cognitive processes occurring outside of conscious awareness.

Response latency data were initially analyzed with a 2 × 2 × 2 × 2 (dot probe position × threat word position x threat word type × exposure condition) analysis of variance (ANOVA). A significant 3–way interaction was found for threat word position, dot probe position, and exposure condition, $F(1, 56) = 4.44$, $p < .05$, indicating that within the subliminal condition, participants showed attentional biases toward threat words (i.e., responding faster when dot probes replaced the threat word of the threat-neutral word pairs and responding slower when dot probes replaced the neutral word of the threat-neutral word pairs), whereas the reverse pattern appeared in the supraliminal condition, demonstrating participants' avoidance of threat words in this condition. Mean dot probe detection latencies for this interaction are shown in Table II. No other main effects or interactions were found. It is important to note that significant differences between social threat and pain attentional biases would have been demonstrated by a 3–way interaction for threat word position, dot probe position, and threat word type, and that significant differences between social threat and pain attentional biases at different exposure levels (subliminal vs. supraliminal) would have been demonstrated by a 4–way interaction.

To explore the meaning of the significant 3–way interaction for threat word position, dot probe position, and exposure condition, data were collapsed by dot probe position and threat word position into one continuous attentional bias score for analyses, following a standard procedure (e.g., Mogg, Mathews, & Eysenck, 1992; Neshat-Doost, Moradi, Taghavi, Yule, & Dalgleish, 2000). This procedure is equal to testing the dot probe position × threat word position interaction for dot probe detection latencies and yields a score reflecting the difference between trials when the dot probe follows threat words in a threat-neutral word pair and when the dot probe follows neutral words in a threat-neutral word pair. In this analysis, mean reaction time data from each trial were entered into the following equation for each participant, which yielded a continuous attentional bias score reflecting magnitude of bias ("U = upper screen position, L = lower screen position, P = probe, and T= threat word"):

$$\text{Attentional bias score} = \frac{1}{2}[(\text{UPLT} - \text{UPUT}) + (\text{LPUT} - \text{LPLT})]$$

For example, for each participant, "UPLT" represents the average of the eight times per condition that the dot probe was in the upper position and the threat word was in the lower position. Positive scores demonstrate an attentional bias to threat, negative scores demonstrate a bias away from threat (i.e., avoidance of threat), and a score of zero reflects no bias toward or away from the threat words compared to neutral words. Four attentional bias scores were created for each participant, reflecting: (a) attention to subliminally presented pain words, (b) attention to supraliminally presented pain words, (c) attention to subliminally presented social threat words, and (d) attention to supraliminally presented social threat words (see Table III for means and standard deviations of these scores.)

To investigate whether children with RAP displayed attentional biases to threat words compared to a neutral attentional stance (i.e., no relative attention to or avoidance of threat words compared to neutral words), the four mean attentional bias scores for threat words were

Table II. Mean Dot Probe Detection Latencies and Standard Deviations (in ms) for Threat-Neutral Word Pairs Involved in the Significant Dot Probe Position × Threat Word Position × Exposure Condition Interaction

Exposure condition/threat word position	Dot probe position	
	Upper	Lower
Supraliminal		
Upper	609.42 (142.55)	603.93 (155.60)
Lower	605.16 (154.09)	621.30 (190.30)
Subliminal		
Upper	599.70 (143.26)	604.57 (154.23)
Lower	611.25 (135.63)	600.97 (153.59)

[3]Following prior dot probe research (e.g., Glinder et al., 2005; Mogg et al., 1995), trials with probe detection latencies less than 100 ms. and greater than 4000 ms. were excluded from analyses. Second, trials with inaccurate responses (e.g., trials in which the dot actually replaced the upper word, but the participant pressed the key indicating that the dot replaced the lower word) were removed. For within-subjects outliers, trials with response latencies greater than two standard deviations above each subject's mean were removed. For between-subjects outliers, each subject's mean response latency scores were applied to an equation collapsing threat word position and dot probe position, described in the body of the paper. Scores that fell above or below two standard deviations from the mean of the overall sample on a particular score were removed from the data set. Approximately 5% of the scores were removed for the above reasons.

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Table III. Means and Standard Deviations of Attentional Bias Scores and Questionnaire Variables

	Mean	Standard deviation
Subliminal pain AB	13.56	40.04
Supraliminal pain AB	–11.00	39.41
Subliminal social threat AB	8.39	37.16
Supraliminal social threat AB	–10.61	46.99
Abdominal pain (child report)	0.0	4.42
Abdominal pain (parent report)	0.0	4.54
Body vigilance	15.57	8.49
Somatic complaints *T*-score	62.19	9.28
Anxiety/depression *T*-score	55.49	7.96

AB = attentional bias.

compared to zero with *t* tests. Results showed that, as hypothesized, participants significantly attended to subliminal pain words versus neutral words, $t(54) = 2.51$, $p < .05$. In contrast to the original hypotheses, children with RAP demonstrated attentional avoidance of supraliminal pain words versus neutral words, $t(52) = -2.03$, $p < .05$. Results also reflected trends for participants to attend to subliminal social threat words, $t(53) = 1.66$, $p < .10$, and avoid supraliminal social threat words $t(53) = -1.66$, $p < .10$.

A 2 × 2 (threat word type x exposure condition) repeated measures ANOVA was conducted using the four attentional bias scores per participant. In this ANOVA, a significant main effect was found for exposure condition, $F(1, 49) = 8.07$, $p < .01$, corresponding to the 4-way ANOVA described above (Fig. 1). The null finding for threat word type indicated that children with RAP did not differ in their attention to pain and social threat words—that is, within each exposure condition, participants' tendencies to attend to or orient away from social threat words and pain words were not reliably different.

The significant main effect of exposure condition was explored to assess whether the differences in attentional bias for pain and social threat words at each level of exposure were significant. Results showed that participants exhibited greater attentional biases to pain words in the subliminal compared to the supraliminal condition, $F(1, 51) = 9.42$, $p < .01$. Participants also showed greater attentional biases to social threat words in the subliminal compared to the supraliminal condition, $F(1, 52) = 4.22$, $p <$ 05. Thus, children with RAP attended to both types of threat words at a subliminal level and avoided both of these words at a supraliminal level.

Correlational Analyses

Age and sex were not significantly associated with attentional bias scores. In addition, none of the variables

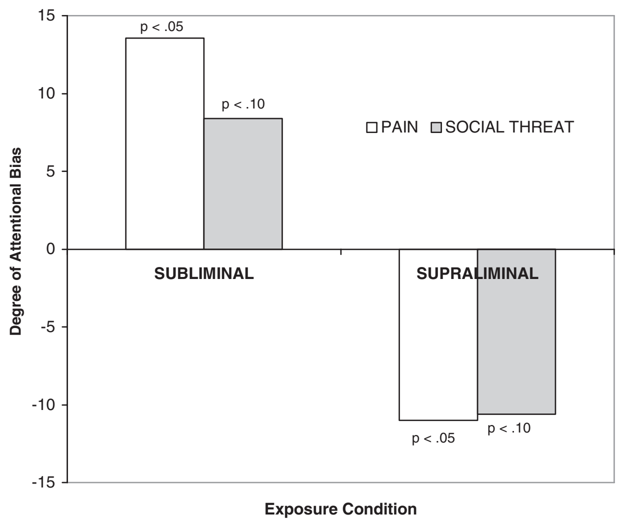

Figure 1. Attentional biases to subliminally (20 ms) and supraliminally (1250 ms) presented pain and social threat words. Compared to their responses to neutral words, children with RAP significantly attended to pain words in the subliminal condition ($p < .05$) and significantly avoided pain words in the supraliminal condition ($p < .05$). They also showed marginally significant attention to social threat words in the subliminal condition ($p < .10$) and marginally significant avoidance of social threat words in the supraliminal condition ($p < .10$). Positive scores = attentional bias toward threat, negative scores = avoidance of threat.

derived from medical charts were associated with attentional bias scores, including length of time the participant had experienced abdominal pain before initial clinic visit, number of symptoms related to RAP reported at the visit, or type of diagnosis (functional vs. organic). No significant relations were found between the variables of interest and the length of time between the initial clinic visit and the dot probe task.

Means and standard deviations of the questionnaire variables are listed in Table III. For CBCL syndrome scale scores, normative data (*T* scores) are reported in the table, although raw scores were used in analyses for greater range of scores. Pearson's correlations were conducted comparing attentional bias scores and questionnaire variables, and are presented in Table IV. Among the attentional bias scores, biases toward supraliminally presented social threat words negatively correlated with both biases toward subliminally presented pain words ($r = -0.30$, $p < .05$) and attentional biases toward subliminally presented social threat words ($r = -0.29$, $p < .05$). These results demonstrate that in general, supraliminal bias scores are negatively correlated with subliminal bias scores, both within and across word type, showing that children who attended to subliminal threat words avoided supraliminal threat words and vice versa. Furthermore, the correlations

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Table IV. Correlations Among Attentional Bias Scores and Psychological/Somatic Variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Supra pain AB	—	—	—	—	—	—	—	—	—
2. Sub pain AB	–.18	—	—	—	—	—	—	—	—
3. Supra social threat AB	–.03	–.30**	—	—	—	—	—	—	—
4. Sub social threat AB	–.18	.00	–.29**	—	—	—	—	—	—
5. Pain, child report	–.03	.13	–.10	.35**	—	—	—	—	—
6. Pain, parent report	–.31**	.12	.14	.12	.60***	—	—	—	—
7. Body vigilance	–.20	.01	–.05	.33**	.29**	.20	—	—	—
8. Somatic complaints	–.06	.17	.01	.28*	.64***	.51***	.40**	—	—
9. Anxiety/depression	.36**	–.01	.13	.07	.20	.02	.01	.31	—

AB = attentional bias, Sub = subliminal, Supra = supraliminal.
$p < .10$*, $p < .05$**, $p < .01$ ***

between threat word bias, within exposure condition, were nonsignificant and close to zero, showing that biases to social threat words were not related to biases to pain words at the same exposure level.

Biases to attend to supraliminally presented pain words were negatively associated with parents' reports of their child's abdominal pain ($r = -0.31$, $p < .05$), but positively correlated with parent's reports of their children's anxiety/depression ($r = 0.36$, $p < .05$). Biases to attend to subliminally presented social threat words were positively correlated with children's reports of body vigilance ($r = 0.32$, $p < .05$) and abdominal pain ($r = 0.35$, $p < .05$), and marginally correlated with parent-reported somatic complaints ($r = 0.28$, $p < .10$).

Discussion

In this study, we predicted that children with RAP would demonstrate attentional biases to pain-related words. When words were presented outside of conscious awareness (subliminally), participants did in fact show a significant attentional bias to pain words versus a neutral attentional stance. At the same time, however, participants attended similarly to social threat and pain words. These findings support pediatric pain models proposing that children prone to developing chronic pain show pronounced attention to pain (e.g., Walker, 1999; Zeltzer et al., 1997). These findings also suggest, however, that these children focus not only on pain but also on other sources of threat, in this case social threat words, at a subliminal level. These findings support our initial hypothesis that children with RAP would show subliminal attentional biases to both pain and social threat versus neutral words. This subliminal scanning for threat could contribute to pain or anxiety in children with RAP outside of their awareness, and could make it difficult for them to focus on important nonthreatening words. It could also reflect the important role of anxiety in RAP, as subliminal biases for threat words have been identified as characteristic of anxiety disorder samples.

When words were presented within conscious awareness (supraliminally), we also predicted that participants would attend to pain words. Contrary to this prediction, participants did not attend to pain words, and in fact they showed significant attentional biases to neutral versus pain words. Furthermore, as they did in the subliminal condition, children with RAP attended similarly to social threat and pain words in the supraliminal condition. That is, they avoided both social threat and pain words compared to neutral words. This finding indicates that children with RAP may actually strategically attempt to *avoid* both pain and social threat reminders once they enter their conscious awareness. When considered together, the subliminal and supraliminal findings may reflect a two-stage attentional process whereby children with RAP register threat in their environments as a result of nonconscious, automatic scanning, and then subsequently attempt to respond to the threat by consciously avoiding and disengaging from it once it enters conscious awareness. This potential pattern of controlled avoidance may be both counterproductive and maladaptive in the long run, especially if the sources of pain and social threat continue to register within children's nonconscious attention. Previous studies have consistently shown that children, including those with RAP, who use disengagement strategies (including avoidance) to cope with stressors have worse outcomes (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001; Thomsen et al., 2002).

As noted above, we did not expect participants to attend similarly to pain and social threat words within conscious awareness because we hypothesized, based on

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current models of pediatric pain and previous findings, that pain words would be a more relevant source of threat. Prior studies using attentional bias tasks have distinguished disorder-relevant threat words from less relevant threat words. For example, individuals with social phobia respond significantly faster to social threat words than to physical threat or neutral words (Asmundson & Stein, 1994), and among motor vehicle accident survivors, those with pain and posttraumatic stress disorder (PTSD) show significant biases to both pain and accident words, whereas survivors with pain but no PTSD show biases to pain words only (Beck, Freeman, Shipherd, Hamblen, & Lackner, 2001). In light of these studies, the findings of this study suggest that both pain and social threat words are salient threat cues for children with RAP. Previous work has suggested that many children with RAP are anxiety prone and our results suggest that sources of social threat may be as relevant to RAP as pain (e.g., Apley, 1975; Campo et al., 2003; Thomsen et al., 2002; Walker et al., 1993).

Future studies should investigate the specificity of attentional biases in children with RAP to understand the salience of additional threat stimuli, and should compare attentional biases between children with RAP and children with anxiety disorders such as social phobia. Interestingly, previous studies demonstrate that children with high anxiety show significant biases *toward* supraliminal threat words (e.g., Vasey et al., 1995), unlike the children in this study who showed significant biases *away* from supraliminal threat words. This difference may be a function of different anxiety levels (the participants in the current sample had moderate but not high levels of anxiety, as measured approximately by the CBCL anxiety/depression *T* score), or it might reflect a pattern of cognitive threat response unique to RAP. The results of this study showing avoidance of threat at a conscious level and concomitant subconscious attention to threat could reflect somatization and conscious emotional avoidance in response to stressors in this sample (Shapiro & Rosenfeld, 1987). Unfortunately, because no other studies we are aware of measure subliminal biases in any sample of children or any pain sample, comparisons cannot be made at this point. Further investigation will be important to examine these possibilities.

Results of this study show that laboratory measures of attention to pain and social threat correlate with certain child and parent-reported questionnaire measures of pain, anxiety/depression, somatic complaints, and body vigilance. Children who avoided supraliminal pain words were rated as having more pain but less anxiety/depression by their parents. This finding suggests that children's conscious avoidance of pain may backfire as a pain management strategy but may reduce apparent emotional distress. In addition, children who attended more strongly to subliminal social threat words showed higher self-reported pain and body vigilance, as well as a trend of higher parent-reported somatic complaints. This finding shows that subliminal attention to threat is in fact related to questionnaire-reported markers of emotional distress and a more general pattern of somatic symptoms, which supports further examinations of subliminal cognitive processing in children. It also indicates that subliminal vigilance for social threat words is more closely related to questionnaire-rated markers of physical pain than subliminal vigilance for pain words, which we would not have predicted in this chronic pain sample. It is possible that even though our undergraduate raters evaluated the pain and social words as having equal emotional valence, children with RAP might rate the social threat words as more distressing, and as a result, more likely to trigger emotional and physical distress. It is also possible that the words are similarly threatening, but that subliminal scanning for social stressors is simply more strongly linked to somatic distress than subliminal scanning for pain cues. Related to this possibility, in a daily diary study of stressors in children with RAP, Walker, Garber, Smith, Van Slyke, and Claar (2001) found that socially stressful events, such as having an argument with a friend, resulted in high levels of somatic symptoms. The results of this study and of Walker et al. (2001) suggest that for children with RAP, socially stressful cues and events are strongly connected to physical distress.

Although this study is the first to use laboratory measures of attention in the study of pediatric pain, it had several limitations. Most importantly, this was a within-subjects study and did not include a comparison or control group. As a result, it is not possible to determine whether the results pertain uniquely to children with RAP. It is possible that these findings could apply to other groups of children (e.g., children with other types of pain and even children without pain). It is also possible that the results could extend to all types of threat words, as well all emotionally valenced words, whether positive or negative. Thus, it is important to note that although this study demonstrated attention and avoidance of threat versus neutral words in children with RAP, it did not show hypervigilance specific to pain words or to pain patients. Future investigations of attentional biases in children with RAP should include a control or

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comparison group to determine whether these findings are unique to this population or not.

A further limitation of this study is the reliance on parent reports on the CBCL to assess children's anxiety/depression and somatic complaints scores. This is common in research with younger children, however, it limits our conclusions about children's own reports of these variables and attentional biases. It will be important for future studies to measure children's self-reported anxiety, especially given the attentional bias scores for social threat words, to see whether this variable accounts for some of the findings. Also, although each word in the dot probe task was chosen to correspond to the age range of our participants, we did not assess whether each participant could read all of the words. We did not test them for comprehension of dot probe words before or after the study because we did not want to prime them or confound the results of possible follow-up dot probe tests. Participants were asked to read study instructions and experimenters noted whether or not participants understood them, however future studies should provide standard reading tests to ensure word comprehension (e.g., Neshat-Doost et al., 2000). An additional limitation was that of the 59 children in the study, only 44 had parents who completed the CBCL, reducing the power of these analyses.

These limitations notwithstanding, this study extends the pediatric literature on psychological factors involved in chronic pain. Studies of children with chronic pain generally rely on questionnaire data, whereas the current study draws on several methods (child-report, parent-report, and child laboratory findings) to more reliably measure psychological factors involved in pain. Along these lines, this study demonstrates that attention to threat is moderately correlated across different methods, such that self-reported attention to painful body states (body vigilance) relates to laboratory-measured attention to threat in children with RAP. This finding, as well as the key finding that children with RAP respond differently to threat versus neutral words, supports current pediatric pain models arguing that attention plays a role in chronic pain (e.g., Zeltzer et al., 1997). These findings also suggest that attention not only to pain, but also to social threat cues, and at both non conscious and conscious levels of processing, may be important components of future models of pediatric pain and potential avenues of future study. In the long term, determining attentional biases among children with RAP may provide important information for the development of assessment tools and interventions.

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