A psychosocial perspective on pediatric functional abdominal pain: risk factors and treatment

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Chapter 6

Attentional bias to activity of different parts of the body in children with functional abdominal pain

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Abstract

Objectives: The present study aimed to investigate whether children with functional abdominal pain (FAP) show an attentional bias for information concerning the activity of their body. Additionally, in accordance with Pennebaker’s symptom perception hypothesis, we investigated whether being presented with information about bodily activity influenced perception of bodily sensations.

Method: Thirty children with FAP and thirty healthy children filled out questionnaires and performed a dot-probe detection task, in which children were shown sham pictures about their bodily activity.

Results: Results showed no attentional bias for gut-activity in either children with FAP or control children, although children with FAP were slower than healthy children on all supraliminal trials in which gut-activity was displayed. Children with FAP and healthy children showed an attentional bias away from supraliminal pictures about heart-activity. Thirty to forty percent of children with FAP experienced an increase in abdominal pain due to the experiment, which holds implications for interventions.

Discussion: We conclude that children with FAP did not show an attentional bias for information about gut-activity, whereas similarly to healthy children they directed their attention away from information about heart-activity. Overall, children with FAP only differed from healthy children concerning their responses to gut-activity, not concerning their responses to other bodily activity.
Introduction

Functional abdominal pain (FAP) is very common in childhood, and usually affects daily life significantly (Chitkara et al., 2005; Youssef et al., 2006). Although the exact etiology of FAP remains elusive, some studies suggest that an attentional bias for pain may maintain or prolong the complaints (Eccleston & Crombez, 1999; Pincus & Morley, 2001; Whitehead & Palsson, 1998). Thus far, only two studies have investigated attention processes in children with FAP (Beck et al., 2011; Boyer et al., 2006). Both studies used the well-known dot-probe paradigm to investigate children's attention allocation to pain-words (Beck et al., 2011; Boyer et al., 2006). The results were contradictory, as one study showed that children with FAP avoided pain-words (Boyer et al., 2006), whereas the other reported that children directed their attention towards pain-words (Beck et al., 2011). Other studies into attention biases for pain making use of pain-words have also yielded mixed results (Asmundson, Wright, & Hadjistavropoulos, 2005; Pincus & Morley, 2001; Roelofs, Peters, Fassaert, & Vlaeyen, 2005; Roelofs, Peters, & Vlaeyen, 2002; Roelofs, Peters, Zeegers, & Vlaeyen, 2002).

An explanation for these mixed results might be that studies are using the wrong type of stimuli to measure attentional biases relevant for chronic pain. Attentional biases for pain-words may be caused merely by the negative valence or familiarity of the words (Richter, Ech, Straube, Miltner, & Weiss, 2010; Roelofs et al., 2002; Schoth & Liossi, 2010). Moreover, as it is normal and adaptive for pain to draw attention, an attentional bias for other stimuli that might get associated with pain over time – e.g., harmless bodily sensations – might be a stronger risk factor for (the continuation of) chronic pain (Eccleston & Crombez, 1999; Lautenbacher, 2010). This idea was also suggested by the symptom perception hypothesis, a theory stemming from the broader literature on medically unexplained symptoms. According to this theory, patients with medically unexplained symptoms are a) more attentive to bodily sensations, scanning their body for signs of threatening activity, and b) more likely to interpret benign, non-noxious bodily sensations as painful or pathological (Pennebaker, 1982; Watson & Pennebaker, 1989). Thus, patients with chronic functional pain might have an attention bias for bodily activity, which may maintain their complaints.

In the present study we investigated whether children with FAP show an attentional bias for information concerning the activity of their body. To do this, a dot-probe paradigm was used similar to the one used by Jellesma, Faddegon and Van der Veek (2011). As bodily activity cannot be measured in a low-cost, non-invasive way, these researchers used sham pictures of what children believed to display their current heart rate as stimuli in their dot-probe task. Similarly, in the present study, we used sham pictures about the activity of the children’s gut, their heart and the circulation in one of their legs. We included pictures about the heart because the attentional bias might not be specific to a certain body part but may include all threatening bodily information (Pennebaker, 1982). Additionally, we investigated whether the attentional bias could actually be attributed to threatening bodily...
information, by including non-threatening control stimuli about blood-flow in one of the legs. To investigate both automatic and controlled attention allocation, we presented all stimuli at preconscious as well as conscious presentation rates (Vasey & MacLeod, 2001; Wolters et al., 2011). As anxiety and depression, other somatic symptoms like headache, and self-reported vigilance for pain have been shown to correlate significantly with attention biases for pain-words (Beck et al., 2011; Boyer et al., 2006), we investigated the effects of these variables as well. Finally, as focusing attention on bodily activity might increase the perception of bodily sensations (Nouwen, Cloutier, Kappas, Warbrick, & Sheffield, 2006; Pennebaker, 1982; Watson & Pennebaker, 1989), we investigated the influence of the dot-probe task on perceived bodily sensations.

In accordance with the literature described above, we hypothesized that children with FAP would show a conscious and preconscious attentional bias for information about the activity of their gut, and, to a lesser extent, for information about their heart rate. We expected that symptoms of anxiety and depression, other somatic symptoms, and self-reported pain vigilance would show significant relationships with these attentional biases. Finally, we expected children with FAP but not healthy children to report increased bodily sensations following the task.

Materials and Methods

Sample

Children with FAP

The clinical group (N=30; 19 girls, 11 boys) was consecutively recruited between January 2010 and June 2011 from a) the general pediatric and pediatric gastroenterology outpatient clinics at a university hospital in the Netherlands, and b) from an outpatient clinic of an academic center for child and adolescent psychiatry, specialized in the psychological treatment of children with FAP. Children ranged in age from 8 to 17 years, with a mean of 13.1 years and a standard deviation of 2.73. The first 17 included children also participated in a randomized controlled trial investigating the efficacy of cognitive behavior therapy versus medical care for children with FAP. Children were eligible if they were between 8 and 18 years of age and fulfilled the following criteria, in accordance with the Rome III criteria (Rasquin et al., 2006): abdominal pain is main complaint, pain lasted at least 8 weeks in past 12 months, no red flags or alarm signals present (e.g., involuntary weight loss, vomiting, significant diarrhea, blood in stool), no physical disease that can explain the symptoms (e.g., Crohn’s disease), no major surgery that can explain the symptoms, no psychosis or autism spectrum disorders. All children approached to participate in the current study, agreed.
Control group
Control children were recruited between May 2010 and June 2011 from a database of children that participated in a previous study of our research group (Van der Veek et al., 2010), and who’s parents had indicated to be interested in participating in future studies. Children that matched the age and gender of the clinical children were screened for inclusion by telephone. If children had experienced abdominal pain regularly (more than four times per year) in the past two years or had any other substantial current physical or psychological problems, they were excluded. If no match could be found in the database mentioned above, which was the case for 6 children, colleagues and acquaintances were asked whether their children were willing to participate. Of the 42 children approached, 30 (71.4%) agreed to participate. Nineteen girls and 11 boys were included (age ranged from 8 to 16 years, mean age=13.2, SD=2.58).

Procedure
The design of this study was experimental. Ethical approval was obtained from the Medical Ethical Committee of the university hospital where children were recruited. Children were asked to participate by one of the researchers. Children with FAP were given the choice to either be tested at home or at the outpatient clinic for child and adolescent psychiatry that participated in this study. Control children were tested at home. When children were tested at home, the experimenter made sure that children could perform the task quietly without distraction. If parents agreed, children received a gift token of €10 for their participation.

Both children and their parents received written information concerning the goals and the procedure of the experiment beforehand, and were required to give written consent prior to the start of the experiment. As for the experiment it was necessary that children believed that the pictures actually displayed a snapshot of the current activity of their body, while in fact, this was not the case, we couldn’t disclose the full purpose and procedure of the experiment before it started. Directly after the experiment, parents and children were debriefed about the full facts of the study.

At the start of the experiment, children filled out the questionnaires concerning abdominal pain, symptoms of anxiety and depression, physical symptoms and self-reported vigilance to pain. Children were also asked to rate how much abdominal pain they experienced just before the dot-probe task started. Then, they performed the dot-probe task, followed by a validation check for subliminal presentation. Next, children were asked to rate their level of abdominal pain at that moment, and to fill out the questionnaires concerning the influence of the task on bodily activity/sensations. When all questionnaires were completed, children and their parents were debriefed about the full facts of the study.
Measures

Dot-probe detection task
Children's attentional orienting to bodily activity was measured using a dot-probe detection task. During a dot-probe detection task, two stimuli are presented to participants on either side of a computer screen, one threatening and one neutral. When these stimuli disappear, a dot appears in either the location of the threatening or the neutral stimulus, and participants are instructed to indicate as fast as they can at what location the dot appeared, by pressing the right key on the keyboard (MacLeod, Mathews, & Tata, 1986). If patients have an attentional bias for the threatening stimulus, they will be faster on trials in which the dot replaces the threatening stimulus (congruent trials) than on trials in which the dot replaces the neutral one (incongruent trials), because their focus will be on the location of the threatening stimulus and thus they will be able to detect the dot more quickly.

Programming and presentation time. The dot-probe detection task was programmed making use of E-prime 2.0 and was presented to the children on a Dell Inspiron 9300 laptop with a 17-inch screen. All pictures and other stimuli were presented on a white background. Following Beck et al. (2011) and Boyer et al. (2006), a black addition mark (+) was presented at the start of each trial for 1000 ms. Pictures were then displayed on the left and right hand side of the screen, separated by 4.6 centimeters (1.8 inch). The center of the pictures were 18.35 centimeters (7.2 inch) apart, displayed at ¼ and ¾ of the width of the screen. Following the pictures, the dot-probe – a black period (.) – appeared at one of the picture locations.

In accordance with Beck et al. (2011) and Boyer et al. (2006), the pictures were displayed for 1250 ms to measure conscious or supraliminal attentional biases. Also in accordance with these studies, we aimed to measure preconscious or subliminal attention biases by displaying pictures for 20 ms. However, because of the refresh rate of the laptop on which the task was programmed, it was only possible to display pictures for 17 ms. Therefore, subliminal pictures were presented for 17 ms, followed by a mask for 1233 ms.

Stimuli. The stimuli used in this task were pictures (size: width 13.75 cm (5.4 inch) x height 9.4 cm (3.7 inch)) of what was to be believed to depict the current activity of the children's gut, their current heart rate, the current circulation in one of their legs, and the current activity of the laptop on which they performed the task. To depict each type of activity, four pictures were used which either schematically displayed the silhouette of a person and the relevant body part, or a laptop (see figure 1). The pictures were deemed suitable for children aged 8-18 years by a team of experienced child therapists (2nd, 3rd and 7th author) and pediatric gastroenterologists (3rd and 4th author). The level of activity was indicated by a meter resembling a speedometer of a car. This meter was allowed to randomly vary between 11 different positions. We chose this many positions to increase the credibility of the experiment. The extremes of the meters on the left and on the right hand side of the picture were marked red, indicating a 'danger zone'. This red
color gradually changed to orange, yellow and green, green indicating a ‘safe zone’. The 11 different positions were all in the green zone, both for ethical considerations (we did not want to scare the children) and practical reasons; this way, it was more likely that the different positions of the meters would not elicit different attentional reactions and could thus be pooled for analyses. The mask for the subliminal trials was constructed by pasting all of the four pictures on top of each other and adding a blurry filter.

To make sure children knew what each picture represented, we explained the pictures in great detail to the children, showing each of the four types of pictures to them and emphasizing that the laptop continuously updated the information about their bodily activity to make new pictures. Then, children were asked to indicate what each picture represented, to be sure they knew what kind of activity each picture displayed. All children found it very easy to rate what each picture represented and none of them made any errors.

**Trials.** As this study included four types of pictures, it was not possible to present every combination of pictures to the children, as this would make the task too long. Therefore, we made the following selection of combinations:

- Gut – laptop
- Heart – laptop
- Gut – leg
- Laptop – laptop
- Leg – leg

Both the laptop and leg pictures were considered to be neutral stimuli, the pictures about the gut and heart threatening. Thus, in the first three types of trials a threatening stimulus was combined with a neutral stimulus. Making use of these trials, we were able to investigate whether attentional biases were present. The laptop-laptop trials were included to establish the baseline RTs of children, and the RTs on these trials were compared to the RTs on the leg-leg trials to investigate whether ‘leg-activity’ was actually perceived as a neutral stimulus by the children.

The three types of neutral – threat trials were presented with the neutral picture on either the left or the right side of the screen. Thus, in total, 8 types of picture-combinations were available. The dot could replace either the left or the right picture, making a total of 16 possible trials. For the neutral – threat trials, trials in which the dot replaced the threatening stimulus were considered ‘congruent’; if the dot replaced the neutral stimulus, the trial was considered ‘incongruent’. Each trial was presented 10 times to the child, 5 times supraliminal and 5 times subliminal, making a total of 160 trials. These were presented to the children in two blocks of 80 trials. The order in which the trials were presented in each block was set randomly beforehand, and was the same for every child. Each type of picture was presented equally often in both blocks. Also, the number of supraliminal and subliminal trials were divided equally between blocks. The position of the meter differed randomly per picture, and this was allowed to be different for every child.
Figure 1. Stimuli used in the dot-probe detection task. Position of meter randomly varied between the extremes depicted in picture a and b.

a. Stimulus depicting gut activity
b. Stimulus depicting heart rate
c. Stimulus depicting circulation in leg
d. Stimulus depicting activity of laptop
e. Mask used for subliminal presentations

Procedure for the dot-probe detection task. At the start of the task, the experimenter explained the children that for the computer task they were going to do, it was necessary to measure the activity of their gut (bowel movements), the activity of their heart (heart rate) and how fast the blood flowed through one of their legs. They were shown the ECG stickers that were going to be used to make these measurements, and how these were connected to the laptop through alligator clips, wires and a device that connected the wires through a USB portal to the laptop. Then, three stickers were put on the children’s abdomen, one was put on their chest and a final sticker was put on one of their calves.
After the ECG stickers were connected to the laptop, children were asked to sit in front of the laptop, approximately 60 cm from the screen. The experimenter made sure the screen of the laptop was in an optimal angle for each child. Then, they received instructions on how to perform the task; they were instructed to look at the fixation mark and respond as quickly as possible to the probe, making as few errors as possible. They were instructed to keep their index fingers on the ‘s’ and ‘k’ keys of the keyboard and to press the ‘s’ when the probe was on the left side of the screen, and the ‘k’ if the probe was on the right side. Subsequently, children were allowed to practice with 8 trials, to make sure they understood how the dot-probe task worked. After this training session, two blocks of 80 trials were presented to the children. They were allowed to take a break after the first block. Finally, children were asked to perform the validation check for subliminal presentation (see below). This entire sequence took about 15 minutes.

**Validation check for subliminal presentation.** To check whether the subliminal pictures were actually processed outside of conscious awareness, we asked children in three subliminal trials following the dot-probe task to indicate whether they saw what picture was displayed on the left and on the right hand side of the screen. They were allowed to choose either of the four possible pictures.

**Questionnaires**

**Abdominal pain.** Level of abdominal pain was measured by the Abdominal Pain Index (API) (Walker et al., 1997). The API consists of five questions, and assesses the frequency, duration and intensity of the abdominal pain the child experienced in the past two weeks. The first two questions make use of a 6-point scale, the third of a 9-point scale and the last two questions of an 11-point scale. A total score for the API was computed by recoding each item so that it reflects a scale ranging from 0 to 10, and summing all items, yielding a total score ranging from 0-50 (Van der Veek et al., 2010). The API has been shown to be a reliable instrument in previous studies, with a Cronbach’s alpha ranging from .80 to .93 (Walker et al., 1997). Cronbach’s alpha in the present study was .94.

**Anxious and depressive symptoms.** Children filled out the Revised Anxiety and Depression Scale – short version (RCADS-25; Muris et al., 2002) to measure symptoms of anxiety and depression. The shortened version of the RCADS has been shown to be a valid and reliable instrument to measure symptoms of generalized anxiety disorder, separation anxiety disorder, social phobia, panic disorder, and major depressive disorder (Muris et al., 2002). Each of the five scales consists of five items that have to be scored on a 4-point scale, ranging from (0) never to (3) always. Cronbach’s alphas of the five scales ranged from .65 to .83 in previous research (Muris et al., 2002). For the present study, the four scales of the different anxiety disorders were summed to compute one score for anxious symptoms. A separate score was calculated for depressive symptoms. Cronbach’s alpha in the present study was .93 for anxious and .77 for depressive symptoms.
Somatic complaints. The Dutch version of the Children's Somatization Inventory (CSI; Garber et al., 1991; Ghys & Meesters, 1993; Meesters et al., 2003; Walker et al., 1991; Walker & Greene, 1989) was used to assess somatic complaints. The CSI contains 35 items that have to be rated on a 5-point scale, ranging from (0) not at all to (4) a whole lot, reflecting the extent to which the symptoms were experienced in the past two weeks. A total score can be computed by summing the scores across all items, with higher scores indicating a higher intensity of somatic complaints. A number of items on the CSI are items concerning abdominal pain, and these items were not used in the total score for this study. The following items were omitted: nausea/upset stomach; constipation; diarrhea; pain in stomach; vomiting; bloated stomach; food intolerance. The CSI has been shown to be a reliable and valid instrument for assessing somatization symptoms in children and adolescents (Meesters et al., 2003).

Pain vigilance. To measure self-reported vigilance to pain, the Pain Vigilance and Awareness Questionnaire was used (PVAQ; Roelofs, Peters, McCracken, & Vlaeyen, 2003; Roelofs, Peters, Muris, & Vlaeyen, 2002). The PVAQ consists of 16 items which can be answered on a 6-point Likert scale, ranging from (0) never to (5) always. It has been validated in a Dutch sample of adult healthy participants and fibromyalgia patients (Roelofs et al., 2003; Roelofs et al., 2002). For the present study, the items were adapted slightly to accommodate the reading level of the children participating in our study. Total scores were calculated by summing all items. Cronbach's alpha in the present study was .88.

Influence of the task on bodily activity/sensations. To investigate whether performing the dot-probe task influenced the perception of bodily symptoms, children were asked in a series of 14 questions designed for this study whether they perceived any changes in bodily activity or sensations due to the dot-probe task they performed. Children were asked to respond on a five point Likert scale ranging from “completely untrue” (1) to “completely true” (5) to the following questions: 1) Because of this computer task, my abdominal pain got worse; 2) When I saw the “abdominal meter”, I got more abdominal pain; 3) When the abdominal meter was low, I thought the abdominal pain would decrease; 4) When the abdominal meter was high, I got more abdominal pain; 5) When the abdominal meter was low, I got less abdominal pain. These 5 questions were repeated for the influence of pictures of the heart and the leg (for this last category, the last question was omitted as it was not applicable to sensations in the leg). Separate total scores were calculated for each type of picture; higher scores meant that children perceived more changes in bodily sensations due to the task. Cronbach's alpha in the present study was .79 for the abdominal pain-scale, .82 for the heart-scale, and .64 for the leg-scale.

To investigate the influence of the task on level of abdominal pain, we used an additional measure; a difference score between how much pain children experienced before and directly after the experiment. Children were asked to rate their abdominal
pain on these two occasions on the same 11-point scale as used by the last two items of the API, ranging from “no pain” (0) to “the most pain possible” (10). Positive scores on this measure meant that the abdominal pain increased; negative scores meant that the abdominal pain decreased.

**Statistical analyses**

Prior to performing the main analyses, we checked whether the stimuli depicting activity of circulation in the legs could actually be perceived as a neutral stimulus, by comparing RTs on leg-leg trials with RTs on laptop-laptop trials. Also, we investigated whether the eleven different meter positions affected RTs. Next, to investigate whether children with FAP showed an attentional bias to information about the activity of their gut compared to healthy children, we first performed a 2 (congruency: congruent vs. incongruent) x 2 (presentation time: supraliminal vs. subliminal) repeated measures ANOVA (RM-ANOVA) on the RTs of gut-laptop trials, with diagnostic group (FAP vs. healthy) and age group (8-12 years vs 13-18 years) as between-subject factors. We corrected for age group as previous research from anxiety literature suggests that attentional biases might be different for younger and older children (Bar-Haim et al., 2007; Wolters et al., 2011). This analysis was repeated for the other threat-neutral trials. Second, we calculated attentional bias scores by subtracting RTs of the congruent trials (dot replacing threat-picture) from RTs of the incongruent trials (dot replacing neutral picture). A positive attentional bias score thus reflects that children direct their attention toward the threatening stimulus, whereas a negative attentional bias score reflects that children direct their attention away from the threatening stimulus. The bias scores were compared with zero to investigate whether any bias was present. Additionally, the scores and were compared between both diagnostic groups to establish whether groups differed in their attentional bias.

It should be noted that although both analytical strategies described above seem to have the same endpoint, there is an important difference that justifies the use of both techniques. The advantage of using attentional bias scores is that these scores cancel out confounding factors influencing RTs like age: younger children usually are slower than older children, but they will be slower on both congruent and incongruent trials, and thus this overall age effect will be cancelled out in the bias scores. A disadvantage of this approach is that it might also cancel out overall effects that we are interested in, like the main effect of diagnostic group on RTs. It is conceivable that the experiment in general or some trials of the experiment might be more stressful for children with FAP than for healthy children, resulting in larger RTs overall for the clinical group (e.g., Jellesma et al., 2011). Therefore, both strategies were used.

To investigate whether attentional bias was related to symptoms of anxiety and depression, other somatic symptoms, and self-reported pain vigilance, we calculated correlations. Finally, to investigate whether the dot-probe task influenced children’s
perception of bodily sensations, we calculated what percentage of children felt changes in bodily sensations in each group and compared these percentages as well as the raw scores on the questionnaires between children with FAP and healthy control children.

Results

Preliminary analyses

Response time preparation and outliers
In accordance with previous studies (Boyer et al., 2006; Wolters et al., 2011), outlying RTs smaller than 100 ms and larger than 4000 ms were deleted, as well as RTs that were at least 3 standard deviations from the individual mean. Additionally, RTs corresponding to erroneous responses (child pressed opposite key) were deleted. Next, before calculating mean RTs per condition, it was investigated whether the eleven different meter positions yielded differences in RTs. Scatter plots and correlations showed no relationships between meter position and RTs per trial type. Thus, mean RTs per condition were calculated, collapsing meter positions. The distributions of these mean RTs were skewed, which was resolved by a log-transformation. Attentional bias scores were calculated by subtracting RTs of congruent trials from RTs of incongruent trials, making use of untransformed RTs. Inspection of the distributions of the bias scores showed significant skewness and kurtosis for every bias score except for the bias score of supraliminal gut-laptop trials. Therefore, parametric tests were used for the supraliminal gut-laptop trials whereas for the other trials, non-parametric tests were used.

For two participants, the masking procedure in the subliminal trials was delayed due to computer failures, resulting in a longer exposure time than 17 ms. These two participants were excluded from analyses on the subliminal trials. Additionally, two children in the control group were outliers on most of the conditions, showing much larger RTs than their peers. These cases were excluded for analyses making use of the log-transformed RT data. For the analyses on attentional bias, only one of these two outliers proved an outlier on most of the bias scores and was therefore excluded from these analyses. Untransformed mean RTs and mean and median attentional bias scores per group are displayed in table 1 and 2.

Credibility experiment
When children were debriefed about the true nature of the study, all but four of them were genuinely surprised to hear that the ECG stickers did not actually measure their bodily activity. The other four children told the experimenter that they already thought the pictures were not real, although they weren't sure of that at the time they were making the dot-probe task. A MANOVA showed no differences in RTs on the different trials between children that
had believed the task and children who had not (Wilks’ Lambda $F(10,44) = .79; p = .327$). Also, no differences were found between both groups on the questionnaires about changes in bodily sensations due to the dot-probe task (Wilks’ Lambda $F(4,55) = .98; p = .910$). Therefore, the data of the children who did not fully believe the task were used for analyses.

**Table 1.** Mean reaction times per diagnostic group on each trial type

<table>
<thead>
<tr>
<th></th>
<th>Congruent trials</th>
<th>Incongruent trials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FAP</td>
<td>Control</td>
</tr>
<tr>
<td>Supraliminal $^a$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gut-laptop</td>
<td>448.08 (92.48)</td>
<td>404.74 (70.21)</td>
</tr>
<tr>
<td>heart-laptop</td>
<td>449.06 (89.97)</td>
<td>413.71 (80.02)</td>
</tr>
<tr>
<td>gut-leg</td>
<td>451.77 (84.9)</td>
<td>419.39 (95.33)</td>
</tr>
<tr>
<td>laptop-laptop</td>
<td>442.23 (84.18)</td>
<td>401.88 (78.98)</td>
</tr>
<tr>
<td>leg-leg</td>
<td>467.82 (94.71)</td>
<td>431.51 (79.70)</td>
</tr>
<tr>
<td>Subliminal $^b$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>gut-laptop</td>
<td>408.72 (65.53)</td>
<td>395.98 (77.85)</td>
</tr>
<tr>
<td>heart-laptop</td>
<td>415.70 (76.54)</td>
<td>401.39 (83.07)</td>
</tr>
<tr>
<td>gut-leg</td>
<td>411.31 (72.38)</td>
<td>392.64 (72.97)</td>
</tr>
<tr>
<td>laptop-laptop</td>
<td>424.58 (76.55)</td>
<td>401.41 (85.79)</td>
</tr>
<tr>
<td>leg-leg</td>
<td>427.97 (73.19)</td>
<td>382.58 (74.57)</td>
</tr>
</tbody>
</table>

$^a$ N for clinical group is 30, N for control group is 28.

$^b$ N for clinical group is 29, N for control group is 27.

**Can leg-pictures be considered neutral stimuli?**

To investigate whether pictures of the circulation in the legs of the children were conceived as neutral by the children, we compared RTs on leg-leg trials to RTs on laptop-laptop trials in a 2 (trial type: leg-leg vs. laptop-laptop) x 2 (presentation time: supraliminal vs. subliminal) RM-ANOVA with diagnostic group and age group as between subjects factors. This analysis showed significant main effects for trial type ($F(1,52) = 6.88; p = .011$), presentation time ($F(1,52) = 24.69; p < .001$), and age group ($F(1,52) = 11.08; p = .002$), and a significant interaction effect between trial type and presentation time ($F(1,52) = 19.80; p < .001$), indicating that all children, both FAP and control, had higher RTs following leg-leg trials than laptop-laptop trials. This effect was more pronounced in supraliminal than in subliminal trials.

Thus, leg-pictures did not evoke similar RTs as the neutral laptop-pictures. In fact, judging from table 1 we can conclude that, compared to all of the other types of trials, both children with FAP and control children were slowest on supraliminal leg-leg trials. These results were not expected beforehand and we could not think of a sound theoretical explanation for them. In fact, we believe that the most straightforward explanation for this finding has to do with some basic feature of the leg-pictures as opposed to the other pictures: as can be seen in figure 1, the leg picture is somewhat more ‘zoomed out’ than the other pictures. This might explain the slow response of children as they might have been distracted by these somewhat different features, or the pictures may have captured their attention less because of the ‘zoomed out’ quality. As the leg-pictures obviously did not
evoke the reaction pattern we expected and as this was most probably caused by a design-
error, we decided to leave any trials making use of the leg-pictures out of further analyses.

Validation check for subliminal presentation

Both children with FAP and control children did not score significantly above chance level 
(25% accuracy rate) on 83.3% of the subliminal trials during the validation check. Of course,
an optimal rate would be that the children would not score above chance on 100% of the 
trials. However, this is mitigated by the fact that prior to the validation check, children were 
specifically instructed that they were going to be asked which picture was presented. 
This might have enhanced their percentage of correct answers. No such instructions were 
given prior to performing the actual dot-probe task; children weren’t even told that during 
masked trials a picture concerning their bodily activity preceded the mask. As even with 
an explicit instruction children were unable to detect the actual picture on nearly all trials, 
we feel it is safe to conclude that the subliminal pictures during the dot-probe task were 
processed outside of conscious awareness.

Main analyses

Attentional bias for activity of the gut

The RM-ANOVAs revealed no significant main effect for congruency \( (F(1,52) = .001; p =.974) \), 
nor a significant interaction effect between congruency and diagnostic group \( (F(1,52) = .257; p =.614) \), indicating that both children with FAP and healthy control children did not 
show an attentional bias for activity of the gut. The only significant effects found were a 
main effect for age group (younger children were slower; \( F(1,52) = 15.48; p <.001 \)) and for 
presentation time \( (F(1,52) = 17.03; p <.001) \).

Because of this latter effect, we performed two subsequent separate RM-ANOVAs 
for supraliminal and subliminal trials. Both analyses also did not show significant main 
effects for congruency \( (F(1,54) = .10, p =.754 \text{ for supraliminal trials}; F(1,52) = .01, p =.926 \) 
for subliminal trials) or interaction effects between congruency and diagnostic group 
\( (F(1,52) = .01, p =.910 \text{ for supraliminal trials}; F(1,52) = .87, p =.355 \text{ for subliminal trials}) \). 
Thus, these results indicate there was no attentional bias for gut activity present in either 
group. The analyses on the attentional bias scores (see table 2) confirmed this absence of 
an attentional bias, as both groups did not score differently from 0 for both supraliminal 
and subliminal presentation rates (bias scores of both groups collapsed because there 
was no difference between groups: supraliminal \( t(58) = .952, p =.345 \); subliminal Wilcoxon signed rank test=711.50, N=57, \( p =.480 \)). Spearman correlation analyses as depicted in 
table 3 showed no significant correlations between attentional bias scores and symptoms 
of anxiety and depression, other somatic complaints, and self-reported pain vigilance in 
either group.
Between group analyses on the separate RM-ANOVAs for the supraliminal and subliminal trials additionally showed that younger children were slower on both types of trials ($F(1,54) = 13.94, p < .001$ for supraliminal trials; $F(1,52) = 16.05; p < .001$ for subliminal trials). For the supraliminal trials, but not for the subliminal trials, a main effect for diagnostic group was found ($F(1,54) = 4.116; p = .047$), with larger RTs for children with FAP than for healthy children. This indicates that when children with FAP were presented either congruent or incongruent supraliminal trials depicting pictures of gut and laptop activity, they were slower to respond to the dot than healthy children. This was not the case for trials that were presented outside of conscious awareness.

**Attentional bias for activity of the heart**

Another RM-ANOVA was performed for heart-laptop trials, investigating the effect of congruency, presentation time, diagnostic group and age group. Again, no significant main effect for congruency was found ($F(1,52) = .25; p = .619$), nor a significant interaction effect between congruency and diagnostic group ($F(1,52) = 1.85; p = .180$). However, a significant main effect for presentation time ($F(1,52) = 7.72; p = .008$) and significant interaction effects between presentation time and diagnostic group ($F(1,52) = 5.09; p = .028$) and presentation time and congruency ($F(1,52) = 5.55; p = .022$) justified separate analyses for supraliminal and subliminal trials. The RM-ANOVA for supraliminal trials revealed a trend for congruency ($F(1,54) = 3.79; p = .057$) and a trend for the three-way interaction between congruency, diagnostic group and age group ($F(1,54) = 3.73; p = .059$). Another main effect was found for age group, with younger children responding slower ($F(1,54) = 13.40; p = .001$). The analyses on the supraliminal attentional bias scores (table 2) revealed that – when bias scores of both groups were collapsed as there was no difference between groups – there was a significant effect (median=-7.50, Wilcoxon signed rank test=623.50, N=59, $p = .048$), indicating that all children directed their attention away from the picture about heart activity on supraliminal trials. Spearman correlations showed a positive correlation between this attentional bias and level of abdominal pain for healthy children (see table 3).

The RM-ANOVA for subliminal trials showed no significant effects except for the same main effect for age group ($F(1,52) = 13.21; p = .001$). Similarly, the analysis on attentional bias score showed no attentional bias for subliminal pictures about the heart (bias scores of both groups collapsed because there was no difference between groups: Wilcoxon signed rank test=960.00, N=57, $p = .289$). Spearman correlations revealed that the attentional bias score for subliminal heart pictures was negatively related to other somatic symptoms in the clinical group, and negatively related to symptoms of anxiety and depression in the healthy group.
Table 2. Means (SDs) and medians of attentional bias scores

<table>
<thead>
<tr>
<th>Total group</th>
<th>Children with FAP</th>
<th>Control children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Median</td>
</tr>
<tr>
<td>Supraliminal</td>
<td>N=59</td>
<td>N=30</td>
</tr>
<tr>
<td>bias gut</td>
<td>5.46 (4.05)</td>
<td>3.1</td>
</tr>
<tr>
<td>bias heart</td>
<td>-11.25 (4.00)*</td>
<td>-7.5</td>
</tr>
<tr>
<td>Subliminal</td>
<td>N=57</td>
<td>N=29</td>
</tr>
<tr>
<td>bias gut</td>
<td>-7.18 (4.50)</td>
<td>-3.3</td>
</tr>
<tr>
<td>bias heart</td>
<td>2.67 (3.91)</td>
<td>6.9</td>
</tr>
</tbody>
</table>

*p <.05 for comparison with value 0. Note. The means for children with FAP and control children did not differ for the supraliminal gut-laptop trials, nor did the medians between both groups differ for the other trials.

Table 3. Spearman correlations between attentional bias scores and questionnaires

<table>
<thead>
<tr>
<th>Level of abdominal pain</th>
<th>Other somatic complaints</th>
<th>Anxious symptoms</th>
<th>Depressive symptoms</th>
<th>Pain vigilance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children with FAP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supraliminal biases</td>
<td>Gut</td>
<td>-.198</td>
<td>-.141</td>
<td>.049</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>.161</td>
<td>.158</td>
<td>-.149</td>
</tr>
<tr>
<td>Subliminal biases</td>
<td>Gut</td>
<td>.120</td>
<td>.232</td>
<td>.287</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>-.236</td>
<td>-.411*</td>
<td>-.084</td>
</tr>
<tr>
<td>Control group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supraliminal biases</td>
<td>Gut</td>
<td>.009</td>
<td>-.290</td>
<td>-.062</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>.387*</td>
<td>-.224</td>
<td>-.205</td>
</tr>
<tr>
<td>Subliminal biases</td>
<td>Gut</td>
<td>.161</td>
<td>-.092</td>
<td>-.165</td>
</tr>
<tr>
<td></td>
<td>Heart</td>
<td>.221</td>
<td>-.223</td>
<td>-.465*</td>
</tr>
</tbody>
</table>

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

N for children with FAP varied between 29 and 30; N for control group varied from 27-29.

Effect of dot-probe task on bodily sensations

On the API difference score measuring differences in abdominal pain from pre- to post-task, 30% of the children with FAP reported an increase in AP due to the dot-probe task and 70% reported no change. In the healthy group, 10% reported a decrease in AP; 86.67% reported no change, and 3.33% reported an increase. These percentages significantly differed between groups ($\chi^2(2) = 9.932; p = .007$). The results on our 5-item scale for felt changes in AP due to the task mirrored these results, as 40% of the children with FAP reported to have felt at least a slight change in AP, whereas this was only the case for 16.67% of the control group; a significant difference ($\chi^2(1) = 4.022; p = .045$). For changes in heart-sensations due to the task, we found that 56.6% of children in the clinical group and 66.7% in the control group felt at least slight changes; these percentages did not differ significantly ($\chi^2 (1) = .635; p = .426$). For sensations in the leg, percentages were lower (36.7% for children with FAP, 23.3% for healthy children), and also not significantly different ($\chi^2 (1) = 1.270; p = .260$). The results of the nonparametric analyses making use of the absolute scores on the scales (see table 4) mirrored the results of these categorial analyses.
Table 4. Means (SDs) and medians of questionnaires about influence task on bodily sensations

<table>
<thead>
<tr>
<th></th>
<th>Children with FAP</th>
<th>Control children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Median</td>
</tr>
<tr>
<td>Change in abdominal pain due to task (API-item; range -10 to 10)</td>
<td>0.45 (.89) a</td>
<td>0.00</td>
</tr>
<tr>
<td>Influence task on abdominal pain (range 1-5)</td>
<td>1.26 (.52) a</td>
<td>1.00</td>
</tr>
<tr>
<td>Influence task on heart (range 1-5)</td>
<td>1.49 (.70) a</td>
<td>1.20</td>
</tr>
<tr>
<td>Influence task on leg (range 1-5)</td>
<td>1.27 (.47) a</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note. Different subscripts indicate that distributions for these variables were significantly different (p < .05) for children with FAP and control children on Mann-Whitney U test.

Discussion

The present experimental study found no evidence for an attentional bias for activity of the gut in either children with FAP or control children. Symptoms of anxiety, depression, other somatic symptoms and self-reported pain vigilance showed no relationships with children’s attentional bias for the activity of their gut. However, children with FAP did have larger reaction times and were thus slower than healthy children on trials in which pictures of gut activity were displayed. One explanation for this slower response rate might be that the pain in itself may interfere with task performance because the chronic presence of pain chronically draws on attentional resources (Eccleston & Crombez, 1999; Pincus & Morley, 2001; Villemure & Bushnell, 2002). However, this implies that children with FAP would be slower on all trials, which was not the case: children were only slower on trials during which they could process the stimuli consciously, not on preconscious subliminal trials. More importantly, this general slowing effect was not present when children were shown information about their heart rate; on those trials, children with FAP had similar reaction times as healthy children. The fact that children with FAP react similarly as healthy children to stimuli concerning the heart but not to pictures about the gut seems to imply that their attentional processing of other bodily sensations is not altered, whereas their processing of information about gut activity might be, although not in the sense of a ‘traditional’ attention bias. However, as this study is the first to investigate an attentional bias for bodily activity in children with FAP, more studies are needed before any definitive conclusions can be drawn.

Concerning information about heart activity, our study found that all children showed an attentional bias for this type of bodily activity. Both children with FAP and healthy children directed their attention away from information about heart activity when this information was processed consciously. As this attentional bias was found in both groups, it seems unlikely that it has any etiological value for pediatric FAP. Indeed, Shields and Murphy showed in a recent experimental study that both low and high health anxious participants showed an attentional bias toward ill-health words, suggesting that interest...
in health is present in everyone (Shields & Murphy, 2011). It is intriguing that this specific stimulus about heart activity elicited an attentional bias whereas information about gut activity did not. A probable explanation for this finding is that children might perceive information about heart rate as more threatening than information about the activity of their gut.

Our last research question considered whether focusing attention on bodily activity might increase the perception of bodily sensations. Our study showed that children with FAP and healthy children did not differ in how many changes in bodily sensations they felt concerning the heart and the leg. However, for level of abdominal pain we did find a difference between groups: only children with FAP reported an increase in abdominal pain from pre- to post task, not healthy children. Although it seems unsurprising that healthy children did not experience an increase in abdominal pain following the task since they experienced little to no pain to begin with, it is remarkable that a short procedure showing sham pictures of bodily information can increase abdominal pain in 30 to 40% of children with FAP. Obviously, this should stimulate researchers in the field of interventions to try to reach the opposite effect. When we assume that the pain increases because of the mere effect of paying attention to bodily sensations, an obvious course of action for interventions is to try to divert patients’ attention away from their bodily sensations; in essence, to distract them. Indeed, it has been shown that explicitly focusing attention on pain can increase the pain experience (Nouwen et al., 2006; Van Laarhoven, Kraaimaat, Wilder-Smith, & Evers, 2010; Villemure & Bushnell, 2002) and thus, distraction could have merit. However, to what extent distraction is effective to reduce pain highly varies across studies, depending on characteristics of the pain, the distraction task and the individual (Eccleston, 1995; Snijders, Ramsey, Koerselman, & Van Gijn, 2010; Verhoeven et al., 2010; Wiech, Ploner, & Tracey, 2008). In fact, when following the line of thought of the symptom perception hypothesis it seems logical that distraction alone will not be sufficient, as the relationship between focusing attention on bodily sensations and experiencing somatic symptoms or pain may not be a direct one, but may be mediated by the way patients interpret their bodily sensations. Others have also suggested that patients with chronic pain may have an interpretation bias, interpreting ambiguous stimuli catastrophically according to predominant accessible schemas (Pincus & Morley, 2001). Catastrophic thinking about pain is suggested to affect the pain experience (Vervoort, Eccleston, Goubert, Buysse, & Crombez, 2010; Vervoort et al., 2005) and even the effectiveness of distraction (Verhoeven et al., 2010). For the present study, we may conclude that it remains unclear whether the increase of abdominal pain in children with FAP is caused by a mere focusing of attention on the body during the task, or whether there are mediating negative or catastrophic interpretations at work. Future studies are encouraged to try to discern this, as it holds practical implications for interventions; if the effect is indeed mediated by explicit or more automatic, implicit negative interpretations, then interventions should try to change such
interpretations in stead of focusing solely on distraction. Within pain-literature no studies have tried to decrease interpretation biases, but results from anxiety literature seem promising (Salemink & van den Hout, 2011). Finally, it should be noted that the observed increase in AP may not be caused by being confronted with information about bodily activity, but by the mere stress of participating in an experiment. Although this effect was also present in the healthy control group, its effects may have been stronger for children with FAP. Future studies are encouraged to apply a more direct test of the hypothesis that focusing attention on the body leads to an increase in symptom perception, by for example experimentally manipulating attention to versus away from bodily stimuli and test effects on symptom perception.

There are some limitations to this study that need to be addressed. First, this study is, next to the study by Jellesma and colleagues (Jellesma et al., 2011), the only one making use of this type of paradigm using sham pictures to investigate attentional biases for bodily activity in children, and more studies are needed to validate the procedure. Second, the results for non-threatening bodily information could unfortunately not be interpreted. Future studies are encouraged to design other experimental studies making use of such a control condition to investigate this effect. Finally, it should be noted that not every child believed our procedure. Although this did not affect reaction times, other researchers should try to make their experiments as convincing as possible.

Despite these limitations, the present study is the first to investigate attentional biases for bodily activity in children with FAP. Although no traditional attentional biases were found toward or away from information about gut activity, we may conclude that children with FAP only differed from healthy children in a) their reaction times to pictures about the gut, and b) the influence of the experiment on perceived abdominal pain. These results imply that if any biases are present in these children, they might be specific for the abdomen. We encourage future researchers to replicate the present study to be able to use the results in treatments for children with FAP.

**Acknowledgements**

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