Attentional Bias to Activity of Different Parts of the Body in Children With Functional Abdominal Pain: An Experimental Study

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Received May 3, 2013; revisions received January 7, 2014; accepted January 10, 2014

Objectives To investigate whether children with functional abdominal pain (FAP) show an attentional bias for their bodily activity, and whether receiving information about bodily activity influenced perception of bodily sensations. Methods A total of 30 children with FAP and 30 healthy children performed a dot-probe task, in which they were shown sham pictures about their bodily activity. Results Contrary to our hypotheses, no attentional bias for gut activity was found in either group. However, children with FAP were slower than healthy children on all supraliminal gut-activity trials, suggesting that pictures of gut activity distracted children with FAP from the task they were performing. Both groups showed an attention bias away from supraliminal pictures about heart activity. As hypothesized, more children with FAP than healthy children reported increases in pain after the experiment. Conclusions Children with FAP seemed more strongly influenced by information about gut activity than healthy children. The present study should be replicated for intervention purposes.

Key words attentional bias; bodily activity; children and adolescents; functional abdominal pain; symptom perception hypothesis.

Functional abdominal pain (FAP) is very common in childhood, and usually affects daily life significantly (Chitkara, Rawat, & Talley, 2005). Although the exact etiology of FAP remains elusive, some studies suggest that an attentional bias for pain may maintain or prolong complaints (Eccleston & Crombez, 1999; Pincus & Morley, 2001; Whitehead & Palsson, 1998). Thus far, only two studies have investigated attention processes in children with FAP, both using the well-known dot-probe computer task (Beck et al., 2011; Boyer et al., 2006). The dot-probe task assesses whether participants attend to or avoid threatening stimuli like words or pictures that are presented on a computer screen. These attention biases can be measured at different levels of information processing: both at an automatic level by presenting the stimuli subliminally (e.g., for 20 ms), and at a conscious level by showing the stimuli for a longer time (e.g., for >1 s; supraliminal presentation). The latter, supraliminal presentation time allows children to control their initial automatic orientation of attention, which is measured by the subliminal presentation duration. As such, it is relevant to investigate attention allocation at both presentation rates, as biases at these levels might be different (e.g., Lonigan, Vasey, Phillips, & Hazen, 2004).

Using this dot-probe paradigm, Beck et al. (2011) and Boyer et al. (2006) investigated the presence of an automatic and more controlled attentional bias to words related to pain in children with FAP. However, although the
studies by Beck et al. and Boyer et al. used a similar task, similar stimuli, and similar presentation times, the results of these two studies were contradictory, as one study showed that when children with FAP were shown pain words at a supraliminal level, they avoided these pain words (Boyer et al.), whereas Beck et al. reported that children directed their attention toward pain words. When the words were presented subliminally, Boyer et al. found that children directed their attention toward pain words, whereas Beck et al. found no attentional bias at this preconscious level. Other studies in adults on attentional biases for different types of pain that made use of pain words have also yielded mixed results (Asmundson, Wright, & Hadjistavropoulos, 2005; Pincus & Morley, 2001; Roelofs, Peters, & Vlaeyen, 2002; Roelofs, Peters, Zeegers, & Vlaeyen, 2002).

An explanation for these mixed results might be that studies are using inappropriate stimuli to measure attentional biases for chronic pain. It can be questioned whether reading a word describing pain evokes the same attentional processes as the sensation of pain. Instead, it has been argued that an attention bias for pain words may be caused merely by the negative valence or familiarity of the words, instead of by an underlying etiological process (Richter, Ech, Straube, Miltner, & Weiss, 2010; Roelofs, Peters, Zeegers, & Vlaeyen, 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—for example, harmless bodily sensations—rather than for the pain itself might be a stronger risk factor for the continuation of chronic pain (Eccleston & Crombez, 1999; Lautenbacher, 2010). This idea was not only suggested within the literature on chronic pain, but also within the broader literature on medically unexplained symptoms by the symptom perception hypothesis. 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 bodily sensations as painful or pathological (Pennebaker, 1982; Watson & Pennebaker, 1989). Thus, patients with chronic 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 task was used similar to the one used by Jellesma, Faddegon, and Van der Veek (2011), and Kroese and van den Hout (2000). As bodily activity cannot be measured in a low-cost noninvasive way, these researchers used sham pictures of what participants believed to display their current heart rate as stimuli in their dot-probe tasks. Similarly, in the present study, we used sham pictures about the activity of the children’s gut and their heart. Pictures about heart rate were included because if children with FAP have an attention bias for bodily activity, this may include all threatening bodily information (Pennebaker, 1982). To investigate both automatic and controlled attention allocation, we presented all stimuli at subliminal as well as conscious supraliminal presentation rates (Vasey & MacLeod, 2001). As other somatic symptoms like fatigue, anxiety/depression, and 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 relationships between these variables and attention biases as well. Finally, as focusing attention on bodily activity might increase the perception of bodily sensations (Bogaerts, Janssens, De Peuter, Van Diest, & Van den Bergh, 2010; Noutwen, Cloutier, Kappas, Warbrick, & Sheffield, 2006; Pennebaker, 1982), we investigated the influence of the dot-probe task on perceived abdominal pain (AP).

In accordance with the literature described above, we hypothesized that children with FAP would show a preconscious and conscious attentional bias for information about the activity of their gut. In light of the discrepant results of previous studies, however, we had no specific hypotheses concerning the direction of these attentional biases (toward or away from the threatening stimulus). We also expected children with FAP to show an attentional bias for heart rate, but we expected this to be less pronounced than the bias for gut activity, as we supposed that information about activity of the gut would be more relevant to them than information about 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 AP following the task.

**Methods**

**Sample**

Demographic characteristics and means and standard deviations (SDs) of the measures used in this study are displayed in Table I for both the clinical and control groups.

**Children With FAP**

The clinical group (N = 30; 19 girls, 11 boys, age range 8–17 years) was consecutively recruited between January 2010 and June 2011 from the general pediatric and pediatric gastroenterology outpatient clinics at a university hospital, and from an outpatient clinic of an academic center for child and adolescent psychiatry, specialized in the
treatment of children with FAP. Children were eligible if they fulfilled the following criteria, in accordance with the Rome III criteria (Rasquin et al., 2006): AP is main complaint, pain lasted at least 8 weeks in past year, no red flags or alarm signals present (e.g., involuntary weight loss, blood in stool), no physical disease or 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, Derlx, De Haan, Benninga, & Boer, 2010), and whose 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 AP more than four times per year in the past 2 years or had any other substantial current physical or psychological problems, they were excluded. These exclusion criteria were determined by parent-report and—in case the child was ≥12 years—child-report. If no match could be found in the database mentioned above, which was the case for six 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 range 8–16 years).

Procedure

This was an experimental study. Ethical approval was obtained from the medical ethical committee of the 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 hospital. Control children were tested at home. When children were tested at home, the experimenter made sure that children could perform the task in a quiet environment. Children received a gift token of €10 for their participation.

Both children and their parents received a letter concerning the goals and the procedure of the experiment beforehand, and were required to give written consent. As it was necessary that children believed that the pictures

Table I. Demographic Characteristics and Means (SDs) on Questionnaires and Dot-Probe Task

<table>
<thead>
<tr>
<th>Variables used in study</th>
<th>FAP (N = 30)</th>
<th>Control (N = 30)</th>
<th>p t-test comparing FAP and control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>13.1 (2.73)</td>
<td>13.2 (2.58)</td>
<td>.885</td>
</tr>
<tr>
<td>Gender (% female)</td>
<td>63.3</td>
<td>63.3</td>
<td>1.000</td>
</tr>
<tr>
<td>Ethnicity (% Caucasian)</td>
<td>90.0</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Level of AP in past 2 weeks (possible range 0–50)</td>
<td>33.01 (11.81)</td>
<td>3.01 (6.58)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Level of AP before task (possible range 0–10)</td>
<td>2.85 (2.64)</td>
<td>0.50 (1.43)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Level of AP after task (possible range 0–10)</td>
<td>3.30 (2.81)</td>
<td>0.30 (1.00)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Other somatic complaints</td>
<td>14.43 (12.34)</td>
<td>7.35 (6.65)</td>
<td>.008</td>
</tr>
<tr>
<td>Anxious symptoms</td>
<td>10.41 (9.96)</td>
<td>8.15 (8.29)</td>
<td>.342</td>
</tr>
<tr>
<td>Depressive symptoms</td>
<td>3.83 (2.98)</td>
<td>2.23 (2.10)</td>
<td>.019</td>
</tr>
<tr>
<td>Pain vigilance</td>
<td>2.09 (.79)</td>
<td>1.55 (.75)</td>
<td>.009</td>
</tr>
</tbody>
</table>

RTs on congruent trials

<table>
<thead>
<tr>
<th>Supraliminala</th>
<th>Gut-laptop</th>
<th>Heart-laptop</th>
<th>Control</th>
<th>Heart-laptop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>448.08 (92.48)</td>
<td>449.06 (89.97)</td>
<td>404.74 (70.21)</td>
<td>413.71 (80.02)</td>
</tr>
<tr>
<td></td>
<td>p=.050</td>
<td>p=.120</td>
<td>p=.510</td>
<td>p=.505</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subliminalb</th>
<th>Gut-laptop</th>
<th>Heart-laptop</th>
<th>Control</th>
<th>Heart-laptop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>408.72 (65.53)</td>
<td>415.70 (76.54)</td>
<td>395.98 (77.85)</td>
<td>401.39 (83.07)</td>
</tr>
<tr>
<td></td>
<td>p=.510</td>
<td>p=.505</td>
<td>p=.826</td>
<td>p=.505</td>
</tr>
</tbody>
</table>

RTs on incongruent trials

<table>
<thead>
<tr>
<th>Supraliminala</th>
<th>Gut-laptop</th>
<th>Heart-laptop</th>
<th>Control</th>
<th>Heart-laptop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>450.49 (91.18)</td>
<td>433.50 (69.43)</td>
<td>410.52 (71.04)</td>
<td>406.99 (71.20)</td>
</tr>
<tr>
<td></td>
<td>p=.067</td>
<td>p=.157</td>
<td>p=.272</td>
<td>p=.826</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subliminalb</th>
<th>Gut-laptop</th>
<th>Heart-laptop</th>
<th>Control</th>
<th>Heart-laptop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>412.77 (83.37)</td>
<td>412.79 (67.56)</td>
<td>389.64 (71.63)</td>
<td>408.67 (72.15)</td>
</tr>
<tr>
<td></td>
<td>p=.272</td>
<td>p=.826</td>
<td>p=.826</td>
<td>p=.826</td>
</tr>
</tbody>
</table>

Note. FAP = functional abdominal pain; AP = abdominal pain; RT = reaction time; SD = standard deviation.

aN for clinical group was 30, N for control group was 28.

bN for clinical group was 29, N for control group was 27.
actually displayed a snapshot of the current activity of their body, while in fact, this was not the case, we could not disclose the full 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 questionnaires concerning AP, symptoms of anxiety and depression, physical symptoms, and self-reported vigilance to pain. Children were also asked to rate how much AP they experienced just before the dot-probe task started. Then, they performed the dot-probe task, followed by a validation check for subliminal presentation. Finally, children were asked to rate their level of AP after performing the dot-probe task and 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 this 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 appears, by pressing the right key on the keyboard (MacLeod, Mathews, & Tata, 1986). If participants have an attentional bias for the threatening stimulus, they are 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 is on the location of the threatening stimulus and thus they are able to detect the dot more quickly.

**Programming and Presentation Time**

The dot-probe detection task was programmed with E-prime 2.0 and was presented to the children on a Dell Inspiron 9300 laptop with a 17-inch screen. All 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 1,000 ms. Pictures displaying bodily activity were then shown on the left and right hand side 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 1,250 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 1,233 ms.

**Stimuli**

The stimuli used in this task were pictures (size: width 13.75 cm x height 9.4 cm) of what was to be believed to depict the current activity of the children’s gut, their current heart rate, and the current activity of the laptop (processing speed) on which they performed the task. To depict each type of activity, three pictures were used that either schematically displayed the silhouette of a person and the relevant body part, or a laptop (Figure 1). The pictures were deemed suitable for children aged 8–18 years by a team of experienced child therapists (second, fifth, and seventh author) and pediatric gastroenterologists (second and fourth author). The level of activity was indicated by a meter resembling a speedometer of a car, which was allowed to randomly vary between 11 different positions. We chose these many positions to increase the credibility of the experiment. The extremes of the meters on the left and right hand side of the picture were marked red, indicating a “danger zone.” This red color gradually changed to green, indicating a “safe zone.” The 11 different positions were all in the green zone, both for ethical considerations and practical reasons; this way, it was more likely that the different positions of the meters would not elicit different attentional reactions and could 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. Then, children were asked to indicate what each picture represented; all children found this very easy.

**Trials**

Children were presented with 80 trials, which simultaneously depicted either gut and laptop activity, or heart and laptop activity. In half of the trials, the location of the threatening stimulus was on the left side of the screen, and in the other half, it was on the right side. 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 congruent and incongruent trial was presented 10 times to the child, both supraliminally and subliminally. Halfway through the task, children were given a break to rest their eyes. The order in which the trials were presented was set randomly, and was the same for every child.
Procedure for the Dot-Probe Detection Task
At the start of the task, children were explained that for the computer task they were going to do, it was necessary to measure the activity of their gut (bowel movements) and the activity of their heart (heart rate). The electrocardiogram (ECG) stickers that were going to be used to make these measurements were shown to the children, as well as how these stickers 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 and one was put on their chest. After the ECG stickers were connected to the laptop, children were asked to sit in front of the laptop, 60 cm from the screen. Then, they were instructed to look at the fixation mark and respond as quickly as possible to the probe, making as few errors as possible. Subsequently, children were allowed to practice with eight trials, and then performed the actual dot-probe task. Finally, children performed a validation check for subliminal presentation, consisting of three subliminal trials after which children were asked to indicate which picture was displayed on each side of the screen. This entire sequence took ~15 min.

Questionnaires
Abdominal Pain. Level of AP was measured with the Abdominal Pain Index (API) (Walker, Smith, Garber, & VanSlyke, 1997). The API consists of five questions, and assesses the frequency, duration, and intensity of the child’s AP during the past 2 weeks. Answers are given on 6-, 9-, and 11-point scales, depending on the item. 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 to 50 (Van der Veek, Derkx, De Haan, Benninga, & Boer, 2010). The API has been shown to be a reliable instrument in previous studies (Walker et al., 1997). Cronbach’s alpha in the present study was .94.

Anxious and Depressive Symptoms. The 25-item Revised Child Anxiety and Depression Scale (RCADS-25; Muris, Meesters, & Schouten, 2002) was used to measure symptoms of anxiety and depression. Reliability and validity of this scale have been well established in previous studies (Muris et al., 2002). Items are rated on a 4-point scale, ranging from 0 (never) to 3 (always). For the present study,
two separate total scores were calculated for anxious and depressive symptoms, which showed good internal consistency (α = .93 for anxious symptoms; α = .77 for depressive symptoms).

Other Somatic Complaints. The reliable and validated Dutch version of the Children’s Somatization Inventory (CSI; Meesters, Muris, Ghys, Reuserman, & Rooijmans, 2003) was used to assess somatic complaints. The CSI contains 35 items that are rated on a 5-point scale, ranging from 0 (not at all) to 4 (a whole lot). A total score was computed, with higher scores indicating more somatic complaints. A number of items measure symptoms closely related to AP, and these were not used in the score for this study: nausea/upset stomach; constipation; diarrhea; pain in stomach; vomiting; bloated stomach; food intolerance.

Pain Vigilance. To measure self-reported vigilance to pain, the validated Pain Vigilance and Awareness Questionnaire (PVAQ; Roelofs, Peters, Muris, & Vlaeyen, 2002) was used. The PVAQ consists of 16 items, which are answered on a scale ranging from 0 (never) to 5 (always). For the present study, the items were adapted slightly to accommodate the reading level of the children (e.g., “I am quick to notice effects of medication on pain” was changed to “I notice quickly if medication reduces my pain”). 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 AP, children were asked to rate their AP before and directly after the experiment on an 11-point scale, ranging from 0 (no pain) to 10 (the most pain possible). A difference score was calculated to assess changes in AP. Positive scores on this measure indicated an increase in AP; negative scores indicated a decrease.

Statistical Analyses

Before performing the main analyses, we investigated whether the 11 different meter positions affected reaction times (RTs). Next, to test the hypothesis that children with FAP show an attentional bias to information about the activity of their gut, we performed two repeated measures analyses of variance (RM-ANOVAs) on the raw mean RTs of congruent and incongruent gut-laptop trials, one for supraliminal trials, and one for subliminal trials, with congruency (congruent vs. incongruent) as within-subjects factor, and 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, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007; Wolters et al., 2011). Second, to test the same hypothesis, we calculated attentional bias scores (AB scores) by subtracting RTs of the congruent trials (dot replacing threat-picture) from RTs of the incongruent trials (dot replacing neutral picture). A positive AB score thus reflects that children direct their attention toward the threatening stimulus, whereas a negative AB score reflects that children direct their attention away from the threatening stimulus. The AB scores were compared with zero to investigate whether any bias was present, and were compared between both diagnostic groups to establish whether groups differed in their attentional bias. Although both the RM-ANOVAs and the AB scores seem to have the same endpoint, there is an important difference that justifies the use of both techniques. The advantage of using AB 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. These analyses were repeated for heart-laptop trials to test the hypothesis that children with FAP show an attentional bias to information about heart activity.

To test the hypothesis that the derived AB scores used in the second set of analyses were related to symptoms of anxiety and depression, other somatic complaints, and self-reported pain vigilance, we calculated correlations. To test the final hypothesis that the dot-probe task influenced children’s perception of AP, we calculated what percentage of children felt changes in pain in each group and compared these percentages using a Chi-square test. In addition, we compared mean change in AP between both groups using a t-test.

Results

Preliminary Analyses

Response Time Preparation and Inspection of Data
In accordance with previous studies (Boyer et al., 2006; Wolters et al., 2011), outlying RTs <100 ms and >4,000 ms were deleted, as such RTs are indicative of
erroneous responses, as well as RTs that were at least 3 SDs from the individual mean. Additionally, RTs corresponding to trials in which the child pressed the wrong key were deleted. As scatterplots and correlations showed no relationships between meter position and RTs per trial type, mean RTs per condition were calculated, collapsing meter positions. The distributions of these mean RTs were skewed, which was resolved by a log-transformation. AB scores were calculated making use of untransformed RTs. Inspection of the distributions of the AB scores showed significant skewness and kurtosis for every score except for the one for supraliminal gut-laptop trials. Therefore, parametric tests were used for the supraliminal gut-laptop trials, whereas for the other trials, nonparametric tests were used. We decided against log-transforming the AB scores to benefit interpretability of these scores.

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 log-transformed RT data and were thus excluded from analyses making use of these data. For the analyses on attentional bias, one healthy child proved an outlier on most of the bias scores and was therefore excluded from these analyses. Untransformed RTs and AB scores per group are displayed in Tables I and II.

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 were not sure of that at the time they were making the dot-probe task. A multivariate analysis of variance (MANOVA) showed no differences in RTs on the different trials between children who had believed the task and children who had not [Wilks’ Lambda $F(10,44) = .79; p = .327$]. Therefore, the data of the children who did not fully believe the task were also used for analyses.

Validation Check for Subliminal Presentation
Both groups did not score significantly above chance level on 83.3% of the subliminal trials during the validation check. Ideally, the children would not score above chance on 100% of the trials. However, before the validation check, children were specifically asked to indicate which picture was presented, which might have enhanced their percentage of correct answers. No such instructions were given before performing the actual dot-probe task. As even with an explicit instruction children were unable to detect the actual picture on nearly all trials, we may assume that the subliminal pictures during the dot-probe task were processed outside of conscious awareness.

### Main Analyses

#### Attentional Bias for Activity of the Gut
Two RM-ANOVAs were performed on gut-laptop trials, investigating the main and interaction effects of congruency, diagnostic group, and age-group separately for supraliminal and subliminal trials. Both RM-ANOVAs did not show significant main effects for congruency [Supraliminal trials: $F(1,54) = .10, p = .754$; Subliminal trials: $F(1,52) = .01, p = .926$] or interaction effects between congruency and diagnostic group [Supraliminal trials: $F(1,52) = .01, p = .910$; Subliminal trials: $F(1,52) = .87, p = .355$]. These results indicate that, contrary to what was hypothesized, there was no attentional bias for gut activity present in either group. Between group analyses on the separate RM-ANOVAs for the supraliminal and subliminal trials showed that younger children were slower on both types of trials between children who had believed the task and children who had not [Wilks’ Lambda $F(10,44) = .79; p = .327$]. Therefore, the data of the children who did not fully believe the task were also used for analyses.

### Tables

#### Table II. Means (SDs) and Medians of Attentional Bias Scores

<table>
<thead>
<tr>
<th>Type of attentional bias score</th>
<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>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Supraliminal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias gut</td>
<td>5.46 (44.05)</td>
<td>3.1</td>
<td>2.41 (49.63)</td>
</tr>
<tr>
<td>Bias heart</td>
<td>-11.25 (40.00)*</td>
<td>-7.5</td>
<td>-15.56 (46.82)</td>
</tr>
<tr>
<td>Subliminal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias gut</td>
<td>-7.18 (48.50)</td>
<td>-3.3</td>
<td>4.03 (55.08)</td>
</tr>
<tr>
<td>Bias heart</td>
<td>2.67 (39.12)</td>
<td>6.9</td>
<td>-2.92 (45.15)</td>
</tr>
</tbody>
</table>

*Note. FAP = functional abdominal pain; SD = standard deviation.

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.

*p < .05 for comparison with value 0.
of trials [Supraliminal trials: F(1,54) = 13.94, p < .001; Subliminal trials: F(1,32) = 16.05, p < .001]. Additionally, these between group analyses showed that for the supraliminal trials, but not for the subliminal trials, a main effect for diagnostic group existed [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.

The analyses on the AB scores (Table II) confirmed the absence of an attentional bias, as the AB scores did not differ from 0 in either group [supraliminal t(58) = .952, p = .345; subliminal Wilcoxon signed rank test = 711.50, n = 57, p = .480]. Spearman correlation analyses (Table III) showed no significant correlations between AB scores and symptoms of anxiety and depression, other somatic complaints, or self-reported pain vigilance in either group.

**Attentional Bias for Activity of the Heart**

Another set of RM-ANOVAs was performed for heart-laptop trials, investigating the effect of congruency, diagnostic group, and age-group separately 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]. A main effect was found for age-group, with younger children responding slower [F(1,54) = 13.40; p = .001]. The analyses on the supraliminal AB scores (Table II) revealed that—when bias scores of both groups were collapsed as there was no difference between groups—there was a significant effect as hypothesized (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 AP for healthy children (Table III).

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 AB scores showed no attentional bias for subliminal pictures about the heart (Wilcoxon signed rank test = 960.00, n = 57, p = .289). Spearman correlations revealed that the AB 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.

**Effect of Dot- Probe Task on Abdominal Pain**

On the API difference score measuring differences in AP from pre- to posttask, 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, 86.7% reported no change, and 3.3% reported an increase. As hypothesized, these percentages significantly differed between groups [χ²(2) = 9.932;
The mean change in AP also significantly differed between groups \((t(38) = 2.712; p = .009)\). Children with FAP reported on average a significant increase in AP \([\text{mean} = .45, \text{SD} = .89; t(29) = 2.76; p = .010]\), with a medium effect size \(d = .50\). Control children reported on average a nonsignificant decrease in AP \([\text{mean} = -.20, \text{SD} = .96; t(29) = -1.140; p = .264]\).

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. As such, our main hypotheses were not confirmed. Taking together both our results and those of the two previously performed studies in children with FAP (Beck et al., 2011; Boyer et al., 2006), it is apparent that the findings on attentional biases in children with FAP are highly inconsistent. After all, Beck et al. and Boyer et al. did show the presence of an attentional bias but in opposite directions, and our study did not find any attentional bias. One explanation for these discrepant results may stem from the fact that we investigated a slightly different type of attentional bias—attentional bias for bodily activity—than Beck et al. and Boyer et al. did—attentional bias for pain words. As such, it is possible that children with FAP simply do not have an attentional bias for bodily activity but do have an attentional bias for pain words. However, this still does not explain why Beck et al. and Boyer et al. found an attentional bias in opposite directions. Overall, it is clear that more studies are needed to discern whether attentional biases for pain or bodily activity are actually present in children with FAP. To investigate these issues, apart from replicating the current study, future researchers are encouraged to design other types of tasks or stimuli (e.g., a task that creates a physical sensation or a dot-probe task that shows other pictorial stimuli relevant to pain).

An unexpected result of our study was that children with FAP were slower than healthy children on all trials in which pictures of gut activity were displayed, irrespective of whether these were congruent or incongruent trials. One explanation for this slower response rate might be that 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, if pain would have interfered with overall task performance, children with FAP would have been slower on all trials, which was not the case: children were only slower on trials during which they could process information about gut activity consciously, not on preconscious subliminal trials or on any of the heart trials. Therefore, the most likely explanation for this finding is that children might have been distracted from the task they had to perform—responding to the dot—when they were presented with threatening information about their gut activity. This phenomenon has been previously described in the literature and labeled “behavioral interference” (Kinds & van den Hout, 2001; Wolters et al., 2011). Thus, although pictures about gut activity did not elicit the traditional pattern of an attentional bias toward or away from the pictures, they did seem to influence attention to some extent. Future studies are encouraged to test the presence of behavioral interference more directly by comparing RTs on threat trials to RTs on trials displaying only neutral stimuli (Wolters et al., 2011).

Third, this study showed that both children with FAP and healthy children showed an attentional bias away from information about heart activity when this information was processed consciously. This suggests that all children may find information about heart activity threatening and try to avoid it. This effect has been found previously in an experimental study in adults focusing on attention allocation to ECG displays, where both patients with panic disorder and controls shifted their attention away from an accelerated ECG (Kroeze & van den Hout, 2000). However, as this attentional bias was found in both healthy children and children with FAP, it seems unlikely that it has any etiological value for pediatric FAP.

Our last research question considered whether focusing attention on bodily activity might increase the perception of bodily sensations. Our study showed that 30% of children with FAP reported an increase in AP from pre- to posttask, whereas healthy children showed no increase in AP. Our hypothesis was therefore confirmed, and the effect size of this increase in AP in children with FAP was medium. Although it does not seem surprising that healthy children did not experience an increase in AP following the task, it is noteworthy that a short procedure showing sham pictures of bodily information can increase AP in 30% of children with FAP. Obviously, this should stimulate researchers in the field of interventions to try to reach the opposite effect. However, in the present study it is unclear what exact processes led to this increase in pain, and depending on the process, other intervention strategies seem appropriate. On the one hand, pain may increase because of the mere effect of paying attention to bodily sensations (Nouwen et al., 2006; Van Laarhoven, Kraaimaat, Wilder-Smith, & Evers,
2010; Villemure & Bushnell, 2002). Then, an obvious course of action for interventions is to try to divert patients’ attention away from their bodily sensations, in essence, to distract them. However, according to the symptom perception hypothesis, the relationship between focusing attention on bodily sensations and experiencing somatic symptoms may be mediated by the interpretation of the bodily sensation. 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 seems to affect the pain experience (Vervoort, Eccleston, Goubert, Buysse, & Crombez, 2010; Vervoort, Goubert, Eccleston, Bijttebier, & Crombez, 2005) and even the effectiveness of distraction (Verhoeven et al., 2010). If the increase in pain found in this study is indeed mediated by explicit or more automatic, implicit negative interpretations, then interventions should try to change such interpretations instead of focusing solely on distraction. 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 stress of participating in an experiment. Although this stress 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 toward 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 one of only a few studies making use of sham pictures to investigate attentional biases for bodily activity, and more studies are needed to validate the procedure. Second, the RTs showed a high variability in both groups. Although this is common for dot-probe studies in children (Van Damme & Crombez, 2009), it does make it more difficult to find significant results. A replication of this study in a larger sample with a more limited age range might solve this problem and increase the power to detect significant attention biases. Third, all children in the control group and some children in the clinical group were tested at home instead of in a standardized lab setting. Although this choice was made for the convenience of the participants and we made sure conditions for every child were similar, this might have introduced some bias. Fourth, children were asked to fill out questionnaires about anxiety, depression, physical complaints, AP, and pain vigilance before performing the dot-probe task, which might have influenced their performance on the task. Finally, it was not assessed to what extent participating children found the heart- and gut-related stimuli threatening. Future studies are advised to add such an assessment.

Despite these limitations, the present study is the first to investigate attentional biases for bodily activity in children with FAP. Overall, the investigated dot-probe task was not able to show the presence of traditional attentional biases toward or away from information about gut activity. However, we may conclude that children with FAP differed from healthy children in (a) their RTs to pictures about the gut, and (b) the influence of the experiment on perceived AP. We encourage future researchers to replicate the present study to be able to use the results in developing new treatment protocols for children with FAP.

Acknowledgments

We would like to thank Daniëlle Hoekman for designing the stimuli used in the experiment and Pauline Willems for her help with data collection.

Funding

Dutch Digestive Foundation, study number SWO 05-09.

Conflicts of interest: None declared.

References


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