Journal of Psychosomatic Research 74 (2013) 479–485

Contents lists available at SciVerse ScienceDirect

Journal of Psychosomatic Research

Somatization is associated with deficits in affective Theory of Mind☆

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ARTICLE INFO

Article history:
Received 4 December 2012
Received in revised form 10 April 2013
Accepted 12 April 2013

Keywords:
Conversion Disorder
Emotional Awareness
Functional Somatic Syndromes
Somatization
Theory of Mind

ABSTRACT

Objective: To determine whether deficits in mental representation of emotion may constitute a mechanism for somatization.

Methods: In this case–control study, we obtained measures of cognitive and affective Theory of Mind, emotional awareness, positive and negative affect, depression, anxiety, and physical symptoms and determined psychiatric diagnoses in consecutive outpatients, aged 19 to 60, with Conversion Disorder ($n = 29$), Functional Somatic Syndromes ($n = 30$), or "explained" Medical Disorders (Controls) ($n = 30$). Main outcome measure was the Animations-L score, i.e., use of words describing emotional content while performing the Frith–Happé Animations (video) Task, an established Theory of Mind measure in which the emotional content of a story is conveyed through movement.

Results: Groups were similar in number of physical symptoms, negative affect, and ability to describe emotional experiences on a written measure that specifically solicited such descriptions. Conversion Disorder and Functional Somatic Syndrome groups scored lower on Animations-L, endorsed significantly less positive affect, and had more anxiety than Medical Controls. Animations-L and positive affect scores were predictive of group membership, with lower scores predicting somatizing conditions.

Conclusions: Relative to Medical Controls, a deficit in the encoding and reporting of emotion when the emotional content of the stimulus is conveyed in action occurs equally in Conversion Disorder and Functional Somatic Syndrome patients and is consistent with previous findings in somatoform disorder inpatients. Difficulty with "conversion" from implicit (action, somatic) to explicit (representational) processing of emotions, exacerbated by anxiety, may constitute a mechanism for somatization.

Introduction

Somatization is a major medical problem. Patients with somatization have significant degrees of disability in social and occupational function, consume an inordinate share of medical resources, and have psychiatric conditions that typically go unrecognized and inadequately treated [1–4]. The problem is exacerbated by the fact that the phenomenon of somatization is not well understood. The purpose of this study is to advance our understanding of whether deficits in the capacity to establish mental representations of emotion may constitute a cognitive mechanism of somatization.

"Theory of mind" (ToM) is the ability to explain or predict behavior [5–7] based on mental states, including thoughts, beliefs, intentions, or feelings attributed to the self or others. Cognitive ToM includes inferences about thoughts and beliefs that explain behavior, whereas affective ToM includes inferences about feelings and motivations that explain behavior [8]. The Frith–Happé-Animations Task (AT) [9,10], originally designed to assess ToM and explore impairments in cognitive ToM functioning [11], consists of video sequences depicting a small and a large triangle that move about in a way that conveys a story. Subjects

Abbreviations: ToM, Theory of Mind; AT, Frith–Happé-Animations Task; LEAS, Levels of Emotional Awareness Scale; UA, Arizona Medical Center Family Medicine; CD, Conversion Disorder; FSS, Functional Somatic Syndromes; MC, medical controls; MADRS, Montgomery Asberg Depression Rating scale; HAM-A, Hamilton Anxiety Scale; SCL-90, Symptom Checklist, Somatic Symptom Subscale. SF-36, Short Form 36-item Health Survey; Animations-L, measure of emotion-related words usage while performing the Frith-Happé Animations Task; TAS-20, Toronto Alexithymia Scale; PANAS, Positive and Negative Affect Scale; MSS, Mental States Stories; ANOVA, one way analysis of variance; SES, socioeconomic status; PTSD, Post Traumatic Stress Disorder; GD, Goal Directed.

☆ Previous Presentations: 58th Academy of Psychosomatic Medicine meeting in Phoenix, Arizona, November 18, 2011; 1st Dutch National Conference on Medically Unexplained Somatic Symptoms, Utrecht, the Netherlands, November 24, 2011; the 70th Annual Meeting of the American Psychosomatic Society, Athens, Greece, March 15, 2012; and the 23rd Annual Meeting of the American Neuropsychiatric Association, New Orleans, Louisiana, March 24, 2012.

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http://dx.doi.org/10.1016/j.jpsychores.2013.04.004

with intact ToM functioning attribute thoughts, feelings, intentions and beliefs to the moving triangles when asked to describe what is happening during the animations. Impaired performance on this task has been most commonly associated with autism spectrum disorders [5,12] and more recently dementia [13] and schizophrenia [14].

The possibility that the AT can be used to assess the capacity to mentally represent emotions can be traced to the work of Michotte [15,16]. Based on the observation that movements of simple geometric shapes induced emotions in research volunteers, Michotte hypothesized that emotion perception is grounded in the analysis of simple motion cues (approach, avoidance, contact intensity), and that the perception of biological motion induces a behavioral state in the viewer that may be experienced as emotional. Nearly a half century later, Premack and Premack [17] used computerized animations of geometric shapes to show that 1 year-old infants recognize the goals of objects and attribute positive or negative value to their interactions well before they can make more complex mental state attributions such as wants or beliefs. These and other findings suggest that properties of movement are a forerunner of complex mental state attributions [9], and are consistent with the view that the capacity for ToM arose from the motor system to detect intentions and thereby predict the behavior of others [18].

The possibility that the AT can be used to detect deficits in affective ToM was first established in an fMRI study of alexithymia, a trait commonly linked with somatization [19–21]. In that study, the AT was administered during fMRI to students who were classified as alexithymic or non-alexithymic [20]. Results demonstrated that the dorsomedial prefrontal cortex was more activated in controls than alexithymic individuals, and this difference correlated positively with perspective taking [20].

These findings are consistent with two studies from a German Psychosomatic Inpatient Unit using the LEAS, a performance measure of the ability to describe one's own and others' emotions in response to hypothetical emotion-evoking scenarios. LEAS scoring defines a continuum that quantifies the tendency to describe emotions as lower level bodily, sensori-motor states or higher level differentiated emotional feeling states [22]. Lower scores on the LEAS are therefore consistent with a deficit in the capacity to mentally represent emotional states. In the first study, inpatients with somatoform disorders compared to patients with other psychiatric diagnoses scored significantly lower on the LEAS prior to treatment, and LEAS scores significantly improved after three months of multi-modal inpatient treatment [23]. In a second study [16], the investigators adapted the LEAS scoring system to measure the emotional content of narratives while performing the AT (i.e., the Animations-L score). Animations-L, therefore, can be considered a measure of affective ToM, as the emotional content must be inferred/mentally represented from the seemingly interactive movements of the triangles. Relative to control subjects, German inpatients scored lower on Animations-L, i.e. they were less likely to attribute emotions to the moving triangles. This study provided further evidence of a deficit in affective ToM in somatoform patients. Their more limited use of emotional words in describing what happened during the animations indicated that somatoform patients were less able to mentally represent the emotional information conveyed by the stimuli.

In the current study we sought to extend previous findings by determining whether previous findings on the AT and Animations-L applied to American outpatients with somatoform conditions and whether the findings varied as a function of somatoform condition type. The study of German inpatients used two types of animations: Goal-Directed, depicting simple goal-directed activity (e.g., fighting), and ToM, depicting more complex interactions associated with more complicated thoughts and feelings. In this study we also included a third type of animation depicting Random Movement, i.e., no specific interactions between characters, which had been used in previous research in other contexts [9]. We selected Conversion Disorder as one of the comparison groups due to the specific and often dramatic physical symptoms that are not medically explained and because of the historical significance of this group in psychosomatic medicine. In contrast, Functional Somatic Syndromes are characterized by medically unexplained physical symptoms that are typically more non-specific and diffuse in nature. We chose the latter rather than Somatization Disorder or Hypochondriasis as a comparison group because Functional Somatic Syndromes are more common and are often seen among highly educated or previously highly functioning individuals.

We therefore hypothesized that outpatients with Conversion Disorder and Functional Somatic Syndromes would manifest impaired affective ToM, as measured by Animations-L, compared to control subjects who had known medical disorders with symptoms that were thought by their physicians not to exceed objective medical findings. We secondarily hypothesized that Conversion Disorder patients would manifest a greater deficit in affective ToM than Functional Somatic Syndrome patients, given that the symptoms of the former are often more dramatic and unusual than those of the latter. The traditional view that psychological conflict or distress participates in the etiology of Conversion Disorder symptoms specifically implicates a deficit in psychological awareness and ability to create mental representations of emotion in this condition. Third, to examine the specificity of our findings relative to affective ToM, we examined performance on a battery of measures of cognitive ToM independent of the AT. We hypothesized that groups would not differ on cognitive ToM.

Method

Subjects

From a total of 330 University of Arizona Medical Center Family Medicine (UA) and 118 Mayo Clinic in Arizona outpatients approached for the study, 59 outpatients with somatizing conditions (29 outpatients with Conversion Disorder and 30 outpatients with Functional Somatic Syndromes); and 30 outpatients with known medical conditions, ages 19 to 60, were consecutively recruited (Conversion Disorder and Functional Somatic Syndrome from Mayo Clinic, Functional Somatic Syndrome and medical controls from UA) between August 2008 and June 2010. Conversion Disorder patients were matched for age and sex to medical control patients, since this was our primary comparison. Those patients who were approached but did not enroll in the study either declined to participate for personal reasons, were not staying in town long enough to participate, did not match the Conversion Disorder patient (in the case of medical controls), or did not meet our inclusion criteria when screened. Conversion Disorder patients were diagnosed by their Mayo physicians according to DSM-IV criteria after a thorough medical and neurological work up to rule out other conditions. Conversion Disorder symptoms included functional paralysis, functional movement disorder, functional dysphonia, or functional behavioral spells (i.e., psychogenic non-epileptic seizures). Patients with Functional Somatic Syndromes were judged by their physician to have somatization, based on the physician's assessment that the patient's physical symptoms were not fully explained by known medical and neurological conditions. Functional Somatic Syndrome patients were variously diagnosed with fibromyalgia, irritable bowel syndrome, chronic fatigue syndrome, vulvodynia, cyclic vomiting/abdominal pain syndrome, or temporomandibular joint syndrome. Medical controls had physical symptoms, were being followed at a university primary care clinic, and were judged not to have somatization by their physician, i.e., the patient's physical symptoms did not exceed those typical for their condition. Diagnoses included diabetic neuropathy, chronic obstructive pulmonary disease, sciatica, chronic back pain, arthritis, migraine headaches, Lyme disease, pulmonary hypertension, or muscular dystrophy. Even in patients with chronic back pain, migraine headaches, and arthritis, medical symptoms were fully explained and there was no evidence of somatization per the clinical judgment of their physicians. Patients were included if their primary language was English, they were between the ages of 18 and 60, they were not actively suicidal, they denied substance abuse or dependence within the past 6 months, were not cognitively impaired, and had no current or past history of psychosis. All individuals gave their written informed consent according to the Declaration of Helsinki, and the study was approved by the Mayo Clinic and University of Arizona Institutional Review Boards.

Assessment of psychiatric and physical symptoms and functioning

Psychiatric diagnoses were made according to the Mini International Neuropsychiatric Interview [24], and levels of depression, anxiety, and physical symptoms were measured with the clinician-rated, 10 item Montgomery Asberg Depression Rating scale (MADRS) [25], clinician-rated 14-item Hamilton Anxiety Scale (HAM-A) [26], and self-report Symptom Checklist (SCL-90) Somatic Symptom Subscale [27], respectively. Quality of life and functioning were measured by the self-report Short Form 36-item Health Survey (SF-36) [28]. Reading ability was measured by the Wechsler Test of Adult Reading [21] and used to estimate general intelligence.

Outcome measures

Frith–Happé-Animations Task (AT)

AT norms have been established by correlating ToM-related brain activity with AT scores in healthy individuals [9]. The AT, as it was used in this study, consists of four animations depicting random movement, e.g., no specific interactions between characters; four animations depicting actions indicative of lower-order attribution of mental states/goal-directedness, e.g., one character's action depended on another's action; and four animations depicting actions indicative of higher-order attribution of mental states/ToM, e.g., actions implying the intention to deceive. Before presenting the twelve animations in random order, participants were informed that they would see animated sequences with three different types of content, (1) random movement, (2) simple interaction and (3) interaction with thoughts and feelings. After a practice animation of each type, participants were instructed to “relax and watch the animations” and subsequently to “describe what was happening in this animation.” Participants' responses were transcribed from voice recordings and then rated for intentionality, i.e., the degree of mental state attribution regarding the implied “intentions” of the triangles' movements (the traditional way of scoring the AT), and also coded for Animations-L (see #3 below). To ensure consistency, they were scored by just one member of the study team, who was blinded to group, with training and experience scoring animations (both intentionality and Animations-L) in previous studies.

LEAS

The LEAS consists of 10 scenarios that describe emotion-evoking interactions between two persons. Participants are asked to describe how they would feel as the protagonist of each scene and how “the other person” would feel. Answers are quantified using scoring rules that have been derived from a cognitive-developmental theory of emotional awareness [29]. Each item is scored 0 to 5 with a maximum score of 50, with higher scores indicating higher emotional awareness. The same study team member who scored the Animations also blindly scored the LEAS.

Emotional content of AT narratives (Animations-L)—primary outcome measure

To determine the level of emotional states that were attributed to the moving triangles in the animations, i.e., affective ToM, AT transcripts were coded according to LEAS scoring rules (scored independently of the LEAS by the same study member, blinded to group). Participants' responses were audiotaped, and emotion-related words were coded separately for the large and small triangles. Scores for each subject consisted of the cumulative sum of scores across the animations. Higher scores reflect more differentiated use of emotion-related words.

Toronto Alexithymia Scale (TAS-20)

The TAS-20 [30,31] asks for the degree of self-reported agreement with 20 statements on a 5-point Likert scale ranging from strongly disagree to strongly agree. The cut-off point that differentiates between alexithymic and nonalexithymic individuals is defined by the test authors as 0 to 51 — nonalexithymic, 52 to 60 — neither nonalexithymic/ nor alexithymic; 61 and above — alexithymic.

Positive and Negative Affect Scale (PANAS-20)

The PANAS-20 [32] is a 20-item questionnaire designed to measure positive and negative affect, with 10 positive affect and 10 negative affect mood-related adjectives. Respondents rate the extent to which, on average, they experience each particular emotion, with reference to a 5-point scale (1 ‘very slightly or not at all’, 2 ‘a little’, 3 ‘moderately’, 4 ‘quite a bit’ and 5 ‘very much’). Positive emotionality appears to increase tolerance for stressful events and has been associated with reduced stress-related illness, mood disturbances, and biological markers for stress [33].

Eyes Test

In this test of one's ability to detect mental states in others [34], another measure of affective ToM, participants are given a picture of a facial expression that only reveals the eyes. Participants are to choose from a list of four words that vary depending upon the particular mental state depicted in the picture of the eyes, e.g., serious, ashamed, alarmed, bewildered. The score is the number correct out of 36 items.

Mental States Stories (MSS)

The MSS [35] served as a measure of purely cognitive ToM function. Four categories of stories (2 involving people, 2 involving objects; one in each category requiring inference and one not) were administered. One of the four categories involves ToM (a person and a mental state inference). Higher scores reflect a greater ability to make pertinent mental or physical state attributions.

Statistical analysis

Each measure of interest, including demographic variables, was summarized by calculating its mean and standard deviation by the group membership (Conversion Disorder ($n = 29$), Functional Somatic Syndrome ($n = 30$), medical controls ($n = 30$)), respectively. Following descriptive analyses, one way analysis of variance (ANOVA) was performed to assess the difference in each measure among the three groups. When significant differences between the three groups were detected, post-hoc Tukey's HSD (Honestly Significant Difference) test was performed to identify the pairs with significant differences within each measure. Where appropriate Conversion Disorder and Functional Somatic Syndrome were combined into one group labeled as SOM to compare with the medical control group using two-sample t test. In addition, Pearson correlation coefficients were calculated between the measures of interest. Correlations were tested for significance using two-tailed t tests.

Multiple linear regression analysis was performed to adjust for potential confounders (e.g. gender) while assessing the difference in each measure between the three groups or between SOM and medical control groups. A trend test was performed to evaluate whether there was a linear trend in the Animations-L mean scores between three types of animations (ToM, Goal-directed, Random). An interaction test between the types of animation and the group membership was performed to evaluate whether the trend varied between the groups. In addition, logistic regression was performed to identify the variables, including PANAS-20 Positive and Negative, TAS-20 and Animation-L (random and ToM), that were predictive of SOM membership. All multiple regression analyses were performed based on the entire sample ($n = 89$). The level of significance was set at $p = 0.05$. Given the exploratory nature of this study, we did not account for multiple comparisons between measures; however, our a priori primary outcome measure was Animations-L score. All statistical analyses were performed using SAS Version 9.2 for Windows (SAS Institute Inc., Cary, NC).

Results

Demographic, psychiatric, and physical symptom comparisons are in Table 1. The Functional Somatic Syndrome group had more females, but other demographic variables, reading ability, and physical symptoms were well balanced among the three groups. Five Conversion Disorder patients had co-morbid Functional Somatic Syndrome symptoms which predated the Conversion Disorder onset. Surprisingly, there were no significant differences in Post Traumatic Stress Disorder (PTSD) diagnosis detected by the MINI, or in a history of trauma. However, of the subjects who reported a history of trauma, about one in four medical control patients had PTSD, whereas only one in ten Conversion Disorder patients and one in eight Functional Somatic Syndrome patients had PTSD. Despite no significant differences between groups in current episode of Major Depression as diagnosed by the MINI, the MADRS detected more depression symptoms in both the somatizing groups than medical controls. Anxiety disorders and the HAM-A scores were greater in the somatizing groups than medical controls.

After adjusting for sex, the Functional Somatic Syndrome group distinguished itself from both the Conversion Disorder and medical control groups in terms of higher self-reports of pain, and the Conversion Disorder group had significantly higher TAS-20 scores than medical controls (Tables 2 and 3). While all three groups reported the same amount of negative affect, somatizing groups reported significantly less positive affect, i.e., lower PANAS-positive scores, than medical controls (Table 3).

Contrary to the previous studies of German inpatients, groups did not differ on the LEAS or AT Intentionality. Groups also did not differ on the Eyes Test or MSS. However, similar to the German inpatients, both somatizing groups scored significantly lower on Animations-L than medical controls in all three categories of AT stimuli (Table 3). The Animations-L mean scores, collapsed across groups, increased as complexity of mental state content of the animations increased: ToM > Goal-directed > Random ($p < 0.0001$). This trend did not significantly vary between groups. Likewise, the Animations-L and intentionality scores were significantly correlated ($p < 0.0001$). Despite using the same scoring system, the LEAS and Animations-L were not significantly correlated. Differences between groups remained in Animations-L when adjusting for PANAS negative affect. However, when adjusting for MADRS, only the Animations-L Random movement scores remained significantly different between groups. Secondary analyses that excluded the 5 Conversion Disorder patients with co-morbid Functional Somatic Syndrome did not substantially change the above results.

HAM-A was negatively correlated with Animations-L ToM ($r = -0.25$; $p = 0.03$); the relationship between anxiety and Animations-L was not as strong for the Goal Directed ($r = -.09$; $p = 0.47$) or Random Movement ($r = -0.22$; $p = 0.06$) stimuli. Although the somatizing groups had both higher HAM-A and lower Animations-L scores than the medical control patients, formal statistical tests of anxiety as a mediator of the association between Animations-L and group were not significant for any of the three categories of AT stimuli.

Based on a logistic regression model, PANAS-Positive affect was predictive of group membership ($p = 0.01$) with lower PANAS-positive scores being more likely to indicate the combined somatizer group compared to the medical control group. PANAS-Negative affect was not predictive of group membership. Animations-L ToM and Animations_L Random were also each predictive of group ($p = 0.02$ for both). When TAS-20 was added to a model with PANAS-positive, both measures became insignificant. When Animations-L ToM was added to a model with PANAS-positive, Animations-L ToM was no longer significant (p-value = 0.06) However, when PANAS-positive and Animations-L Random were included in the model, both PANAS-Positive and Animations-L Random were still significant (p-value = 0.01).

Table 1
Demographic, psychiatric, and physical symptoms comparisons

Variable	CD ($\overline{X}$[a] ± SD[b]) (N = 29)	FSS ($\overline{X}$ ± SD) (N = 30)	MC ($\overline{X}$ ± SD) (N = 30)	p-Value[c] overall
Age	42.4 ± 12.4	43.4 ± 11.2	45.0 ± 12.3	0.72
Male	24.1%	6.7%	33.3%	0.03
SES	Working class 11.5% Middle class 50.0% Upper class 38.5%	Working class 6.9% Middle class 41.4% Upper class 51.7%	Working class 19.1% Middle class 57.1% Upper class 23.8%	0.33
Education[e]	Low: 3.5% Middle: 55.1% High: 41.4%	Low: 0.0% Middle: 50.0% High: 50.0%	Low: 4.0% Middle: 60.0% High: 36.0%	0.94
Wechsler Test of Adult Reading	38.33 ± 7.09	37.75 ± 8.90	37.27 ± 9.64	0.90
MDD current (%)[d]	31.0	50.0	29.2	0.24
PTSD (%)[d]				
Past trauma (%)	6.9	10.0	12.5	0.55
	72.4	76.7	55.6	0.20
GAD, panic d/o, social anxiety d/o, or OCD (%)[d]	41.4	50.0	3.3	0.01
HAM-A	15.4 ±1.3	17.9 ± 1.2	4.1 ± 1.8	<.01
MADRS	15.4 ± 1.7	19.2 ± 1.7	6.6 ± 2.8	<.01
SCL-90 somatic subscale	28.69 ± 9.21	30.53 ± 9.23	27.77 ± 10.49	0.53
SF36 physical functioning	52.59 ± 31.50	43.39 ± 28.74	51.79 ± 35.14 (N = 28)	0.47
SF36 general health	53.45 ± 21.10	40.83 ± 24.77	51.12 ± 24.42	0.10

[a] Mean.
[b] Standard deviation.
[c] Derived from one-way ANOVA for continuous variables and Fisher's exact test for categorical variables (sex, SES and education). SES = socioeconomic status.
[d] Derived from M.I.N.I.: MDD = Major Depressive Episode; GAD = Generalized Anxiety Disorder; PTSD = Post Traumatic Stress Disorder; CD = Conversion Disorder; FSS = Functional Somatic Syndromes; MC = Medical Controls.
[e] Years of Education: Low: high school not completed. Middle: high school or trained in a vocation. High: college/university completed.

Discussion

Our finding of lower Animations-L scores in somatizing patients compared to a medical control group indicates that somatizing patients perform less well on a measure of affective ToM. Levels of anxiety, positive affect, and Animations-L scores were strikingly similar for Conversion Disorder and Functional Somatic Syndrome patients, and these measures distinguished the non-somatizing patients from somatizing patients. These findings replicate those from a German study of inpatients with Somatoform disorder, but with different comparators than the previous study. The somatoform patients in the current study may be less severely affected, given that this is an outpatient sample, and our control group may be more impaired, given that this group is less physically healthy and more physically symptomatic than the previous control group. The consistent finding of lower Animations-L scores in a wide range of somatizing patients suggests that deficits in the mental representation of emotion, as demonstrated by our findings with Animations-L, may constitute a mechanism for somatization.

Both somatizing groups had similar deficits in using emotional words to describe social scenarios with emotional content depicted in movement, suggesting that a deficit in affective ToM is not associated with the phenotypic expression of somatizing conditions. This finding is consistent with previous work in which we [36] and others [37] found many more similarities than differences in patients with functional movement disorders and psychogenic non-epileptic seizures. If there is indeed a similar mechanism for somatization despite differing phenotypic expressions, we would expect that treatment approaches could be unified for these differing conditions. The ability to mentally represent emotional states may be an important component of treatment that deserves further study [38].

Physical sensations alone do not imply emotionality. When confronted with physical symptoms a person must be able to make sense out of them by linking them with an emotional state, a concept or thought, or a social interaction. Likewise, in order to do well on the Animations-L, one must understand the emotional meaning of the actions depicted and, without prompting, connect this understanding to a verbal representation of the emotional content. In the case of the LEAS, both the stimuli and the responses are verbal and the instructions prompt respondents to describe their feelings. To the extent that somatization involves difficulty in creating mental representations of bodily experiences, the LEAS may be less sensitive in detecting

Table 2
Comparison of SF-36[a] quality of life subscale scores among groups

Variable	CD ($\bar{X}$[c] ± SD[d]) (N = 29)	FSS ($\bar{X}$ ± SD) (N = 30)	MC ($\bar{X}$ ± SD) (N = 30)	p-Value[e] overall (adjusted)[b]	Tukey's HSD multiple comparisons (adjusted)[b]
SF36 role limitations due to physical health	34.05 ± 33.56	19.17 ± 22.92	43.75 ± 35.11 (N = 28)	0.01 (0.06)	MC > FSS (NS[f])
SF36 role limitations due to emotional problems	43.10 ± 38.19	37.22 ± 31.77	61.31 ± 37.97 (N = 28)	0.04 (0.09)	MC > FSS (NS)
SF36 energy (higher scores)/fatigue (lower scores)	29.43 ± 24.07	20.89 ± 19.55	39.05 ± 27.68 (N = 28)	0.02 (0.12)	MC > FSS (NS)
SF36 emotional well being	55.86 ± 24.06	55.93 ± 25.21	66.00 ± 27.92 (N = 28)	0.24 (0.39)	NS (NS)
SF36 social functioning	43.53 ± 27.88	34.58 ± 28.56	54.02 ± 35.69 (N = 28)	0.06 (0.20)	NS (NS)
SF36 pain	44.66 ± 27.90	26.50 ± 19.10	42.95 ± 28.15 (N = 28)	0.01 (0.03)	CD > FSS; MC > FSS (CD > FSS; MC > FSS)

CD = Conversion Disorder; FSS = Functional Somatic Syndromes; MC = Medical Controls.
[a] Higher score reflects better quality of life.
[b] Adjusting for sex.
[c] Mean.
[d] Standard deviation.
[e] Derived from one-way ANOVA.
[f] NS: none of pair-wise comparisons based on the HSD test is significant.

the propensity for somatization than Animations-L. The fact that the LEAS did not differentiate between groups in our sample, as it did in the previous German studies, could in part stem from the higher level of functioning (outpatients vs. inpatients) and the higher level of education (greater number who completed high school) in the patients in our study.

The previous German study did not include animations depicting random movement, and therefore did not assess Animations-L random movement scores (but did include Goal-Directed and ToM scores). In the current study, Animations-L random movement scores in combination with PANAS positive affect were a stronger predictor of group than ToM Animations-L scores. Moreover, we observed that as both the inherent emotional content of the stimuli and the explicitness of the prompt to describe feelings increase, i.e., going from Animations-L Random to Animations-L ToM to LEAS, the difference between somatizing and control patients decreases. The absence of group differences with the Eyes Test is also consistent with this trend, as the stimuli in that test inherently depict emotional (or cognitive) states and the possible verbal labels for the stimuli are provided in a multiple choice format. These results indicate that in addition to making fewer emotion attributions in emotion-evoking situations, somatizing patients make fewer emotional attributions by default, i.e. they make fewer emotional attributions in response to stimuli that do not inherently contain emotional content. This may be relevant to the context of physical sensations, which may not have an inherent emotional meaning. Emotions associated with physical symptoms that are not predicted or represented in situations that would be distressing normatively lead to somatic sensations that have no explanation, which itself creates anxiety and fuels the focus on somatic symptoms [39]. Furthermore, a tendency to not immediately make emotional attributions to their physical symptoms could explain why many patients with somatization may then reject emotional or psychological factors as contributing to their physical symptoms [40,41].

Recent scientific studies of the experience of emotions suggest that the process of applying “emotion words” to sensory information goes beyond simply naming or attaching a verbal label to the experience. Rather, verbalizing creates mental representations of the sensory information that formulates the experience as an emotion or socially

Table 3
Comparison of emotional awareness, alexithymia, positive/negative affect and Animations-L measures among groups

Variable	CD ($\bar{X}$[b] ± SD[c]) (N = 29)	FSS ($\bar{X}$ ± SD) (N = 30)	MC ($\bar{X}$ ± SD) (N = 30)	p-Value[d] overall (adjusted)[a]	Tukey's HSD multiple comparisons (adjusted)[a]	p-Value[f] (SOM[g] vs. MC) (adjusted)[a]
LEAS total	31.90 ± 3.82	33.60 ± 4.60	32.34 ± 4.85	0.32 (0.51)	NS[e] (NS)	0.68 (0.98)
TAS-20 total	53.38 ± 12.87	50.30 ± 13.35	44.45 ± 12.68 (N = 29)	0.03 (0.04)	CD > MC (CD > MC)	0.01 (0.02)
PANAS-20 Negative	21.86 ± 7.43	22.64 ± 7.66	21.36 ± 9.35	0.83 (0.90)	NS (NS)	0.63 (0.71)
PANAS-20 Positive	27.14 ± 8.09	27.15 ± 9.04	32.30 ± 8.37	0.03 (0.04)	NS (NS)	0.01 (0.01)
Animations-L: Random movement	0.13 ± 0.30	0.13 ± 0.31	0.32 ± 0.39	0.05 (0.04)	NS (NS)	0.01 (0.01)
Animations-L: Goal Directed	0.28 ± 0.37	0.28 ± 0.41	0.58 ± 0.53	0.01 (0.03)	MC > CD; MC > FSS (MC > CD; MC > FSS)	<0.01 (0.01)
Animations-L: ToM	1.30 ± 0.90	1.13 ± 0.89	1.68 ± 0.81	0.05 (0.14)	MC > FSS (NS)	0.02 (0.05)

LEAS = Levels of Emotional Awareness; TAS-20 = Toronto Alexithymia Scale: PANAS = Positive and Negative Affect Scale; ToM = Theory of Mind; CD = Conversion Disorder; FSS = Functional Somatic Syndromes; MC = Medical Controls.
[a] Adjusting for sex.
[b] Mean.
[c] Standard deviation.
[d] Derived from one-way ANOVA.
[e] NS = none of pair-wise comparisons based on the HSD test is significant.
[f] Derived from two-sample *t*-test.
[g] SOM = CD and FSS.

situated conceptualization [42]. That is, the emotional words themselves may influence the way sensory information is processed [43]. Although speculative and not directly tested in this study, it may be that whether or not emotion words are used in conjunction with a somatic symptom may actually influence how the somatic symptom is perceived and experienced, as well as how the physical symptoms evolve. Having a mental representation or label of an emotional state enables people to do something with the state, such as recognize the feeling, determine what the feeling indicates about what the person needs, and plan what to do to enhance adaptation in a situation [44]. Enabling emotion regulation in this way may enable patients to better manage their anxiety in response to physical symptoms and may over time reduce anxiety levels.

Anxiety as measured by Ham-A was negatively correlated with Animations-L in the context of ToM stimuli. Even though anxiety did not significantly mediate the relationship between group and Animations-L, it is nonetheless quite possible that anxiety contributes to a somatic focus. The association may be bidirectional, as anxiety may compromise one's tendency to make emotional attributions of physical sensations, and a lack of emotional attribution could lead to increased anxiety. Such linkages would be consistent with the known positive associations between medial prefrontal cortical activity and vagal tone [45], the known positive associations between medial prefrontal cortex and mentalizing ability [20] and the known reductions in vagal tone in anxiety [46].

Our data suggests that somatoform patients have a deficit in the explicit experience of positive emotion, consistent with indications that positive affect facilitates stress management [33]. Whether maintenance of positive affect during stress protects against somatization is not known, though there is evidence that overall outcomes of patients with chronic conditions are better for those who have relatively high positive affect [47], and patients with greater positive affect exhibit lower pain-catastrophizing [48]. Indeed, when combining all three groups, we saw strong, significant correlations between lower positive affect and greater physical and emotional distress as measured by the SF-36.

Unlike the demonstrated deficit in affective ToM as measured by the Animations-L, there were no differences between the somatizing groups and medical controls on measures of cognitive ToM, i.e. MSS and AT intentionality. Therefore, the deficit we describe does not appear to stem from a diminished cognitive capacity for understanding another's mental states involving cognitions or in the capacity to use emotional words or perceive emotions when prompted to do so, e.g., on the LEAS or the Eyes Test. Rather, the deficit we describe is in spontaneously finding and verbalizing emotional meaning in action (bodily) stimuli.

Limitations of this study include comparing patients from two different medical settings, i.e., Mayo Clinic, a tertiary referral center, and a university-based primary care clinic, which was necessary in order to include sufficient numbers of patients in the three groups. Future studies would preferably compare subjects from the same medical setting. Apart from our pre-specified main outcome measure of the Animations-L and secondary measure of the LEAS (hypotheses driven by the prior German study), this was also an exploratory study involving multiple comparisons, and those results are subject to type I errors. Also, selection of patients in part depended on clinical judgment of the physician that somatization was or was not present, which may have been subject to error. This potential source of error is particularly important for the medical controls, some of whom suffered from chronic pain, and could therefore potentially overlap with the Functional Somatic Syndrome patients. On the other hand, our results did not change when patients with pain were excluded from the control group, and subjective assessments of somatization are the rule in clinical practice, making our results all the more relevant. There was also overlap of the somatizing groups as we included 5 Conversion Disorder patients who also had Functional Somatic Syndromes. However, secondary analyses without those patients did not substantially change our results. We also matched controls to Conversion Disorder, resulting in the sex differences between Functional Somatic Syndrome and medical controls. However, statistically controlling for sex did not substantially change the results. Finally, we do not know whether patients who declined to participate in this study represent a different subgroup of somatizing patients than those who did participate, but unwillingness to participate in the study might be associated with less openness to psychological interpretations and possibly lower affective ToM.

Despite these potential sources of error, we have replicated the prior finding of lower Animations-L scores in somatoform patients. Animations-L measures the tendency to find and describe emotional meaning in action (bodily) stimuli, and thus may be relevant to one's tendency to recognize that one's physical symptoms are manifestations of emotional responses. Our findings provide an alternative to Freud's classic hypothesis that in Conversion Disorder unconscious emotional memories are "converted" into somatic symptoms, and suggest that instead there is a relative failure to convert somatic sensations into mentally represented emotions. Further behavioral, physiological and neuroanatomical studies with regard to the proposed mechanism associated with somatization are warranted.

Conflicts of interest

None.

Funding

This work was funded by the Institute for Mental Health Research (grant # 2008-LR-804, Drs. Lane and Stonnington) and Mayo Clinic (Dr. Stonnington).

Acknowledgments

This work was funded by the Funded by Institute for Mental Health Research (grant # 2008-LR-804) and Mayo Clinic (08-001718). Authors thank Sandra Yee-Benedetto (study coordination), Carolyn Fort (study coordination, Animations and LEAS scoring), Hollis Weidenbacher, Jeanne Young, Jessie Jacobsen (data gathering), Marcy Watchman (clinical assessment and data gathering), Mary Larez (recruiter in the Family Medicine Clinic), Andew Flores (transcription of recorded animation descriptions), Erika Driver-Dunckley, M.D., Katherine Noe, M.D., Ph.D., Lucinda Harris, M.D., April Chang-Miller, M.D. (Mayo Clinic patient referrals), Karen Weihs, M.D. (review of previous draft), and the journal reviewers for their excellent comments and suggestions. The authors have no competing interests to report.

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