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Brief communication

Anticipation of body-scaled action is modified in anorexia nervosa

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ABSTRACT

Patients with anorexia nervosa frequently believe they are larger than they really are. The precise nature of this bias is not known: is it a false belief related to the patient's aesthetic and emotional attitudes towards her body? Or could it also reflect abnormal processing of the representation of the body in action? We tested this latter hypothesis by using a body-scaled action-anticipation task in which 25 anorexics and 25 control participants had to judge whether or not an aperture was wide enough for them to pass through. The anticipation of body-scaled action was severely disturbed in anorexic patients; they judged that they could not pass through an aperture, even when it was wide enough (i.e. they behave as if their body was larger than in reality). The abnormally high "passability ratio" (the critical aperture size to shoulder width ratio) was also correlated with the duration of illness and the degree of body concern/dissatisfaction. Our results suggest that body size overestimation in anorexia nervosa is not solely due to psycho-affective factors but rather suggest impaired neural processing of body dimensions that might take its source in parietal networks.

1. Introduction

When watching oneself on video, it is commonplace to experience a feeling of strangeness about one's face and body. It is as if a person's representation of his/her anatomical features does not strictly correspond to the "reality" that the video provides. In some extreme cases, the distortion of this representation is so strong that it becomes pathological, such as in anorexia nervosa (AN). Anorexic patients usually report feeling fatter and larger than they really are. Even though a slight (<5%) overestimation bias is found in normal subjects, the phenomenon is significantly exaggerated in anorexics (Smeets, Ingleby, Hoek, & Panhuysen, 1999). This body size overestimation is considered to be a major clinical symptom of AN (cf. DSM IV; American Psychiatric Association, 1994) and is a cause for concern for several reasons. Firstly, the feeling of dissatisfaction generated by body size overestimation may be a risk factor for developing eating disorders (Stice & Shaw, 2002). Secondly, it could reinforce depression and suicide attempts in adolescents (Franko & Striegel-Moore, 2002; Rodriguez-Cano, Beato-Fernandez, & Llario, 2006). Thirdly, body size overestimation in AN could counteract the benefits of therapy by increasing the obsessive will to lose weight and, as a consequence, maintaining restrictive eating behaviours (Heilbrun & Friedberg, 1990). Hence, understanding the nature and cause of body size overestimation in AN is a major challenge in public health.

Although the exact nature of this cognitive bias and its consequences are poorly known, it is generally accepted that body size overestimation reflects a distortion of body representation. There are at least two types of body representation: the body schema and the body image (for a recent review, see De Vignemont, 2010). The body schema is a dynamic sensorimotor representation of the body which initiates and guides actions. It is elicited by action, regardless of whether the latter is imagined, anticipated or executed (Gallagher, 2005; Paillard, 1999; Schwoebel & Coslett, 2005). The notion of body image is more complex and concerns perceptual, semantic, aesthetic and emotional representations of the body which are not used for action (De Vignemont, 2010).

Thus, the body overestimation bias found in anorexia nervosa could be a mere 'state of mind' – a false belief caused by psycho-affective factors and restricted to the aesthetic-emotional body representation: the body image. Alternatively, it could reflect abnormal neural processing of the embodied self which disturbs the representation of the body in action, i.e. the body schema.

Even though most of the studies to date have stressed emotions/attitudes towards the body (for a review, see Cash & Deagle, 1997; Skrzypek, Wehmeier, & Remschmidt, 2001), very few researchers (Nico et al., 2009, for example) have suggested that the body schema could be also distorted in AN. One likely reason for this

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scarcity is the difficulty with which the hypothesis can be tested. Some indirect evidence exists, such as haptic task impairments in anorexic patients. The latter have been linked to dysfunction of the right parietal cortex (Grunwald et al., 2001, 2002; Roberts, Tchanturia, Stahl, Southgate, & Treasure, 2007), since the parietal lobe is known to play a key role in the representation of body space (Daprati, Sirigu, & Nico, 2010). However, the haptic perceptual tasks used in the experiments involved external objects or lines and not the body itself. On the other hand, pictures or videos of the body cannot be used to test the possible involvement of the body schema. As very rightly noted by Nico et al. (2009) "...by directly inquiring on body image, these measures poorly dissociate between the effects of top-down influences induced by emotions/attitudes towards the body and disturbances of body-size perception due to proprioceptive disorders or a distorted body schema."

In order to investigate overestimation of perceptual-motor body representation in AN, we used an ecological paradigm in which the participant was not confronted with an external body image but was required to represent her body's dimensions in a simulated action. The subject had to imagine whether or not she could pass through a given aperture without turning the shoulders sideways and when walking at a normal speed. In other words, the task consisted in making passability judgments (on the basis of a mental simulation) for apertures of different widths. It should be noted that predicting the effects of actions is a fundamental brain function and is crucial in optimizing motor decisions (Wolpert, Ghahramani, & Jordan, 1995).

Warren and Wang (1987) showed that a visual judgment of passability through an aperture is related to an invariant, perceived ratio (π_p) between the perceived critical aperture and the shoulder width. In normal subjects, π_p was found to be 1.16, whatever the individual's corpulence: an aperture was judged in advance to be "passable" if its width was greater than 1.16 times the observer/actor's shoulder width.[i] Judging the passability through an aperture can be considered as a first-person visuomotor imagery task in which perceptual inputs (the length of the path and the width of the aperture) are interfaced with the motor system in order to predict the action's consequences (passage or failure). It is now well established that motor imagery and movement execution share kinematic and neural properties. For instance, Sirigu et al. (1996) observed that it is possible to use motor imagery to predict the time needed to perform visually-guided pointing movements for targets of different sizes. As with movement execution, the duration of mentally simulated movements was inversely related to the logarithm of the target width (in accordance with Fitts' law (Fitts, 1954)).

Decety and Jeannerod (1996) reported the same pattern of results for mentally simulated actions with gates of different apparent sizes. Imagined walking (like overt walking) increased (in accordance with Fitts' law) for decreasing apparent gate widths. The fact that patients with parietal lobe damage have selectively impairments in predicting motor performance through mental simulation (Sirigu et al., 1996), suggests that the parietal cortex plays a key role in simulating body-scaled actions.

Together with the observed neural overlap between areas activated by imagined and overt actions (for a review, see Grèzes & Decety, 2001), these results can be interpreted as evidence that motor imagery tasks are valuable and appropriate for assessing body schema integrity (De Vignemont, 2010; Schwoebel & Coslett, 2005). If body size overestimation in AN is indeed rooted in distorted perceptual-motor dimensions of the body, one can expect to see an increase in π_p in the AN group as a result of an increase in the perceived critical aperture relative to the true shoulder width.

[i] It must be noted that a π_p value of 1 means that the perceived critical aperture is equal to the shoulder width, which potentially represents a danger of collision with the sides of the aperture if the action is actually performed. Consequently, this result ($\pi_p > 1$) can be interpreted as a safety margin.

2. Method

2.1. Participants

Twenty-five women with AN participated in the study. All had suffered from eating disorders for at least 1 year and fulfilled the DSM IV criteria for AN (American Psychiatric Association, 1994). The subject's age ranged between 17 and 42 (mean: 24.32; SD = 6.54). The time since onset of AN ranged from 1 to 22 years (mean: 5.3; SD = 4.8). The mean body mass index (BMI) was 15.14 (SD = 1.55). At the time of the study, the patients were being treated in the Addictions Unit at Lille University Hospital or the Psychiatric Department at Saint-Vincent de Paul Hospital (both in Lille, France).

The control group consisted of 25 healthy women. They were matched with the patients for age (range: 17–41 years; mean: 23.04; SD: 5.98) and the number of years spent in full-time education (relative to the high-school leaving examination). The mean BMI in the control group was 21 (SD = 1.99). The Mini-International Neuropsychiatric Interview (MINI) confirmed the absence of disorders according to the DSM IV criteria (Sheehan et al., 1998).

The clinical evaluation of the participants did not reveal any perceptual, attentional or intellectual deficits. Subjects with a history of neurological, ophthalmic or bone and joint problems were excluded. Subjects were asked to mention all ongoing medications and treatments. Each participant received a study information sheet and signed an informed consent form. Parental consent was required for minors. The study was approved by the regional independent ethics committee.

2.2. Material and procedure

Body dissatisfaction and concerns about weight and shape were assessed in both control and patient groups with the body shape questionnaire (BSQ) and eating disorder inventory-2 (EDI-2), respectively. The BSQ quantifies the role of an excessive concern for the physical appearance (Cooper, Taylor, Cooper, & Fairburn, 1987). The EDI-2 consists of 11 scores measuring psychological features commonly associated with eating disorders (Garner, 1991). We used the three following scores: the total score, sub-scale A (which measures the drive for thinness) and sub-scale C which evaluates the degree of body dissatisfaction

2.3. Subjective body size estimation (BSE)

Body size estimation was assessed by the presentation (using E-Prime software) of 21 drawings of body shape (i.e. a contour drawing scale) over three trials and in a random order. Each shape was correlated with a BMI standard (see Gardner, Stark, Jackson, & Friedman, 1999). Each participant had to decide whether the shape was fatter or thinner than (or equivalent to) that of her own body. The BMI for the supposedly equivalent body shape was then compared with the participant's actual BMI. The difference between the two values defined the degree of body under- or overestimation.

2.4. Anticipation of body-scaled action

Fifty-one apertures (varying from 30 cm to 80 cm with a 1 cm increment) were projected onto a wall in a random order (the constant stimuli method in E-prime software). In order to maintain the presentation's ecological dimensions, the video projector was positioned sufficiently far away (5.50 m) to allow the projection zone to reach the floor and present a 2 m-high aperture (like a real

Table 1
A summary of the demographical and clinical characteristics of patients suffering from anorexia nervosa and the healthy control subjects. Educational level: the number of years in full-time education, after (+) or before (−) the high-school leaving examination; BMI: body mass index; BSE: body size estimation; BSQ: body shape questionnaire; EDI: eating disorder inventory-2; DT: drive for thinness; BD: body dissatisfaction.

	Anorexic patients (n = 25)				Control subjects (n = 25)				p
	Mean	SD	Median	Min; Max	Mean	SD	Median	Min; Max	
Age	24.32	6.54	23	17; 42	23.04	5.98	21	17; 41	0.5031[a]
Educational level	2.6	2.2	2	−1; +7	2.56	2.55	3	−3; +9	0.7561[a]
Height (cm)	166.67	5.9	167	155.5; 180	166.7	4.82	166	157; 176	0.9191[a]
Weight (kg)	42.2	5.67	43	31; 52	58.56	7.67	56	47; 73	<0.0011[a]
BMI (kg/m^2)	15.14	1.55	15.3	12.7; 18.2	21	1.99	20.5	18.2; 24.9	<0.0011[a]
Shoulder width (cm)	37.66	2.37	38	30; 40.5	40.92	1.78	41	38; 45	<0.0011[a]
Hips width (cm)	30.68	2.34	30.5	25; 35	35.16	1.84	36	31; 38	
BSE (%)	13.6	10.46	12.75	−1.8; +34.3	5	11.22	5.6	−16; +21.3	0.0091[b]
BSQ	135.12	35.52	136	50; 189	71.4	16.28	67	46; 103	<0.001[a]
EDI-2 total	110.76	39.48	109	41; 180	25	14.39	22	5; 50	<0.001[a]
DT	12.24	6.15	14	1; 20	2.36	2.8	2	0; 9	<0.001[a]
BD	16.84	6.92	16	2; 27	7.72	6.07	7	0; 21	<0.001[a]

[a] Mann–Whitney *U*-test.
[b] *T*-Test.

door-type aperture). The participant stood upright behind the video projector, at a distance of 5.90 m from the wall on which the aperture was projected. She was instructed to imagine herself walking through the aperture and, subsequently, to say (i.e. without actually performing the action) whether she would be able to walk at a normal speed through the presented aperture without turning sideways. Each aperture was presented four times but the overall order was random. We determined the perceptual threshold corresponding to the perceived critical aperture, i.e. the aperture for which we obtained a 50% positive response rate ("Yes, I can walk through without turning sideways"). The perceived critical aperture was calculated as follows:

$$\text{Answer} = \frac{1}{1+\exp^{(-k(\text{c-aperture}))}}$$

where c is the perceived critical aperture (in cm) with a 50% "yes" response rate and k is the slope of the curve around the point c.

For each participant, the perceived passability ratio (π_p) was determined by dividing the perceived critical aperture by the shoulder width. The slope of the psychometric curve provided information on the discriminability of the performance: a steep slope corresponds to good discrimination and a shallow slope corresponds to poor discrimination.

All statistical analyses were performed with Statistica software (version 7.1). Non-parametric Mann–Whitney and Spearman tests were used in the event of non-normal distributions and non-homogenous variances between groups.

3. Results

3.1. Morphological and clinical parameters (Table 1)

As expected, there were no significant differences between the AN and control groups in terms of age (median$_{AN}$: 23 years, median$_C$: 21 years: U = 278; Z = 0.669; p = 0.503) or educational level (median$_{AN}$: 2 years, median$_C$: 3 years: U = 296.5; Z = 0.31; p = 0.756). No differences were observed for height (median$_{AN}$: 167 cm, median$_C$: 166 cm; U = 307; Z = −0.107; p = 0.919). However, the BMI was significantly lower in the AN group (median$_{AN}$: 15.3, median$_C$: 20.5; U = 0.5; Z = −6.054; p < 0.001). The shoulder and hip widths were significantly greater in the control group than in the AN group (median$_{AN}$: 38 cm, median$_C$: 41 cm; U = 67; Z = −4.763; p < 0.001 for shoulders and median$_{AN}$: 30.5 cm, median$_C$: 36 cm; U = 38.5; Z = −5.316; p < 0.001 for hips), reflecting the patient's state of malnutrition.

The EDI-2 scores were significantly higher in the patients group as well as concerning the total score (median$_{AN}$: 109, median$_C$: 22; U = 5.5; Z = 5.957; p < 0.001) or the sub-scores respectively, "search for thinness" (median$_{AN}$: 14, median$_C$: 2; U = 50; Z = 5.093; p < 0.001) and "body dissatisfaction" (median$_{AN}$: 16, median$_C$: 7; U = 96; Z = 4.2; p < 0.001). The scores were also significantly higher in the patients group for the BSQ (median$_{AN}$: 136, median$_C$: 67; U = 40.5; Z = 5.277; p < 0.001).

3.2. Behavioural data

3.2.1. Subjective body size estimation (BSE)

Data on two patients could not be taken into account because of aberrant responses. Patients with AN overestimated their body size (mean: 13.6%, SD: 10.46) more than the control group did (mean: 5%, SD: 11.22): t_{46} = 2.73; p = 0.009.

3.2.2. Anticipation of body-scaled action

The data are illustrated in Table 2. The analysis revealed a significant difference between the two groups (see Fig. 1) in terms of the perceived ratio (π_p = perceived critical aperture/shoulder width). Anorexic patients had a significantly higher median ratio (median$_{AN}$: 1.34) than control participants (median$_C$: 1.126): U = 203.5; Z = 2.115; p = 0.034. Moreover the analysis of the slopes of the psychometric curves failed to reveal a significant inter-group difference in discriminability (U = 286; Z = −0.031; p = 0.975).

In order to test the relationship between the passability ratio on one hand and body concerns/dissatisfactions (BSQ score, EDI-2 total score and sub-scores "search for thinness" and "body dissatisfaction") on the other, a correlation analysis of the whole sample was performed using Spearman's coefficient (ρ). It revealed a significant, positive correlation between (1) π_p and the BSQ score (ρ = 0.393; t_{48} = 2.959; p = 0.0025, one-tailed test), (2) π_p and the EDI-2 total score (ρ = 0.377; t_{48} = 2.819; p = 0.0035), (3) π_p and the EDI-2 "drive for thinness" score (ρ = 0.359; t_{48} = 2.664; p = 0.003) and (4) π_p and the EDI-2 "body dissatisfaction" score (ρ = 0.414; t_{48} = 3.155; p = 0.001). Moreover, the analysis showed a significant positive correlation between the BSE and π_p (ρ = 0.264; t_{46} = 1.858; p = 0.04). In the anorexic patients, π_p was also related to the duration of the disease (ρ = 0.360; t_{23} = 1.851; p = 0.038) and the body concern/dissatisfaction scores (for BSQ: ρ = 0.357; t_{23} = 1.835; p = 0.039; for EDI-2 "drive for thinness": ρ = 0.392; t_{23} = 2.045; p = 0.026; for EDI-2 "body dissatisfaction": ρ = 0.353; t_{23} = 1.812; p = 0.041). However, the correlation between BSE and π_p failed to reach significance (ρ = 0.106; t_{21} = 0.488; p = 0.315). It must be noted that the three patients with an atypical, low ratio (see Fig. 1) did

Table 2
The slope, critical aperture and π_p ratio values in the two groups.

	Anorexic patients (n = 25)				Control subjects (n = 25)			
	Mean	SD	Median	Min; Max	Mean	SD	Median	Min; Max
Slope	−0.583	2.458	−0.592	−11.978; −0.299	−0.678	0.393	−0.588	−2.251; −0.153
Critical aperture (cm)	50.222	12.189	49.665	32.433; 72	46.97	7.408	46.686	35.433; 68.412
Ratio	1.33	0.307	1.34	0.874; 1.89	1.147	0.154	1.126	0.886; 1.52

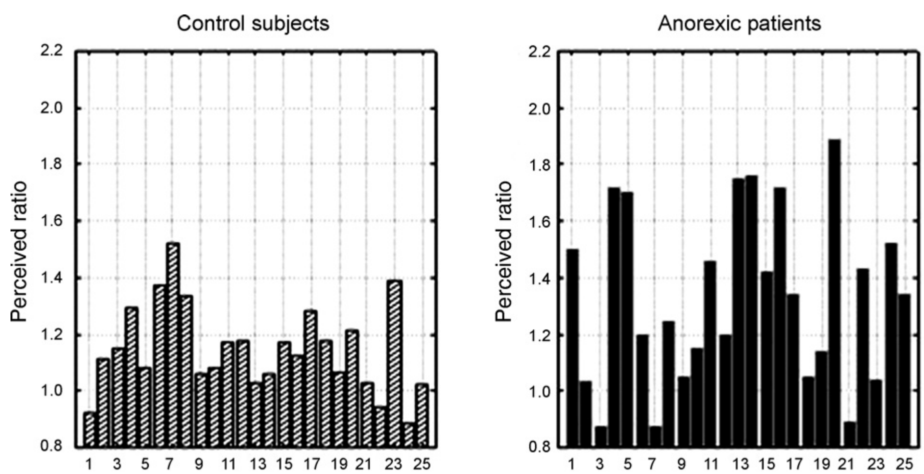

Fig. 1. Individual π_p perceived ratios (critical aperture in cm/shoulder width in cm) in anorexic patients (n = 25) and in control subjects (n = 25).

not significantly overestimate their body size in the BSE task. Two of these patients had very small overestimations (0.87% and 0.78%) and the third was not able to perform the BSE task correctly.

4. Discussion

As expected, the anorexic patients significantly overestimated the passability of the aperture relative to their own shoulder width (median π_p = 1.34) and did so more than the matched control group (median π_p = 1.126). Moreover, in the control group, the value of the π_p ratio (mean$_C$: 1.15) did not differ significantly from that found in Warren and Wang's experiment (mean π_p = 1.16): $t_{24} = -0.422$; $p = 0.68$). In contrast, the mean π_p in the patient group was significantly higher than the value found by the latter authors ($t_{24} = 2.80$; $p = 0.0049$). The observed AN versus control difference cannot be readily explained by poorer discrimination of visual stimuli by the anorexics because no difference (versus controls) in the slope of the psychometric curve was observed. The abnormally high π_p ratio observed here in anorexics also concords with the clinical complaints in such patients, who often claim that they feel fat. It also fits with the body size overestimation usually found in this population when figure contour drawing scales are used (as confirmed here). Indeed, in the BSE task (with direct confrontation with body shapes), the anorexic patients showed greater body overestimation than matched controls did.

Concerning the increase in the passability ratio in AN, any comparison of our results with those obtained by Nico et al. (2009) must take account of the different tasks used in the two studies. The latter authors found a rightward shift of the left shoulder limit in their AN group (e.g. underestimation of the size of the left body side) by using a task in which the participants had to decide when the trajectory of a visual point hit each side of their body. In our experiment, we did not explore a possible right versus left deviation in judgment of the aperture size. If slight left hemineglect exists in AN, it could lead to a rightward translation (Vallar, Guariglia, Nico, & Bisiach, 1995) of the visual space, which in turn would lead to an increase in the perceived critical aperture relative to the shoulder width (as seen in the present work). The left side of the perceived aperture would be neglected and the right side would be translated to the right. Future research should take into account the left versus right sides of the estimated aperture.

Another interesting finding is the positive correlation between the passability ratio and the disease duration: the greater the passability ratio, the longer the period since onset of AN. For instance, the 5 patients who had a disease duration of 10 years or more showed π_p ratios above 1.30 (patient CS05: disease duration = 22 years, π_p = 1.7; patient GE21: disease duration = 10 years, π_p = 1.89; patient DA15: disease duration = 10 years, π_p = 1.76; patient LK23: disease duration = 10 years, π_p = 1.43; patient DS27: disease duration = 13 years, π_p = 1.34). The passability ratio seems to be particularly affected in long-duration of AN. Indeed, Heilbrun and Friedberg (1990) have proposed that a distorted body image not only could initiate dieting behaviour but also could maintain it even when a very thin body is attained. One possible explanation of the increased ratio in anorexic patients could be that the patient's body schema (modified by the rapid weight loss which appears at the onset of the disease) had not been updated by the central nervous system. However, the observed correlation with disease duration rather suggests a continuous worsening in the neural processing of body estimation over time.

The other key findings of the present study are the positive correlations (for the study population as a whole) between π_p and the other tests (BSE, EDI-2, BSQ). This observation prompts us to suggest that π_p could be an interesting, sensitive marker of corporeal bias – even in young women who have not been diagnosed as anorexics. However, one limitation of our study relates to the lack of correlation between the passability ratio and the BSE scores in the AN group. Given the sensitivity of these scales to methodological factors and the lack of reliability/validity of some of them (for a review, see Gardner & Brown, 2010), this absence may be due to the methodology used in our experiment. The participant did not select the shape that most represented their current body but had to state whether each shape presented was thinner or fatter than (or equivalent to) their current body shape. Moreover, the shape was displayed on a screen and not presented (as is usually the case) on a sheet of paper. However, the lack of significance could also result from a low sample size relative to the effect size of the potential link between the BSE score and the π_p ratios. This latter supposition is supported by the fact that the relationship was significant for the sample as a whole (i.e. AN patients and controls). It would be interesting to study additional measures of body representation (such as blind pointing to different parts of the subject's body, such as the shoulders, waist and hips, for example (Hach & Schütz-Bosbach, 2010)) in this respect.

Another potential limitation of the present study relates to the fact that a visual representation of the body could have been activated at the time when the aperture had to be judged. Hence, it could be argued that the participants were only required to imagine walking through the aperture rather than actually doing so. This in turn could have required access to a conscious representation of the body as a perceptual object. It is clear that our mental imagery task was a conscious task; nevertheless, it is probable that the body schema (and not the body image) operates during consciousness and guides the subject's decisions (see Jeannerod, 1994; Schwoebel & Coslett, 2005, for example). It is well documented that in motor imagery, the body in action is not represented as an external object, in contrast to when we imagine an object in motion (see Stevens, 2005, for instance). As mentioned by Schwoebel and Coslett (2005) and De Vignemont (2010) respectively, "both actual and mentally simulated movements may depend on the body schema" and "even without claiming that the body schema is all the time conscious, one may at least argue that it can be conscious in some circumstances, like in motor imagery."

Another argument in favour of our interpretation is provided by the report from Stefanucci and Geuss (2009). They showed that the visual perception of apertures (in a size-matching task with no anticipation of action) is biased by the observer's shoulder width. Indeed, narrow-shouldered participants considered the "absolute" size of a given aperture to be larger than broad-shouldered participants did. This finding suggests that the mere perception of an aperture width per se (in the absence of an action-oriented passability judgment) automatically elicits the body schema. According to Stefanucci and Geuss (2009), humans appear to use their body size as a perceptual metric.

Nevertheless, it will be informative to film AN sufferers when they really pass through different apertures and to encode the aperture for which they begin to turn sideways. Moreover, by manipulating factors as the walking speed and the distance, it would also be possible to confirm that performance of the simulated action (execution time, for instance) follows Fitt's law (like true execution of the action). However, even when a real action is performed, the intervention of visual imagery of body cannot entirely be ruled out and the introduction of a compelling counting task is likely to decrease the feasibility of the locomotor task itself. Nevertheless, if possible that body image components are activated, the fact that anticipation of a passability task was affected here suggests that the body schema is perhaps not immune to top-down influences.

To the best of our knowledge, there are few literature data on the interaction between body schema and body image at both the behavioural and neural levels. However, this dual concept has been questioned. For instance, De Vignemont (2010) recently suggested a dynamic, Bayesian approach to body representation which focuses on a task's specificity and demands (e.g. action-oriented tasks versus non-action oriented tasks) and which goes beyond mere bottom-up and top-down views of body representations. Moreover, Legrand (2010) has proposed a phenomenological view of bodily self-consciousness in AN, although the particular status of body schema (which is not always unconscious) was not addressed. According to the latter author, body consciousness is neither purely subjective (experiencing one's belongingness to the physical world) nor purely physical (experiencing one's body as one's own). It is generally accepted that body self-consciousness has both subjective and physical dimensions. In AN, the relationship between these dimensions may break down.

Taken as a whole, our results support the idea of a relationship between the representation of the body in action and emotional/aesthetic attitudes towards the body. One's conscious body image (with its aesthetic and emotional components) could be based on a more basic representation of the body involved in action: the body schema. Our results suggest that the "predicted" body schema elicited by a mentally simulated action is overestimated in AN and that overestimation is accentuated with disease duration. It is one thing to represent oneself as larger and another to change one's actual or anticipate behaviour because of this.

Neuropsychological investigations and neuroimaging studies (Mohr et al., 2009; Nico et al., 2009) are promising approaches for seeking to explain the link between the various aspects of the cerebral representation of the body in AN. In particular, studies in neuroimaging are already planned by our team in order to highlight the precise cortical areas involved when a body-scaled action-anticipation task is performed by contrast to a task of visual imagery of one's own body in a passive posture. The present findings may also open up new therapeutic perspectives for countering body size overestimation in AN. Therapeutic methods should be based on body-scaled actions. By consciously confronting the patients with what they think they can do and what they can actually do (really being able to pass through an aperture sized to their shoulders for instance), we could improve their perceptual-motor body representation. In view of the observed link between the anticipation of body-scaled action (π_p) and body concerns and dissatisfactions, we could expect to see an improvement in both the perceptual-motor and emotional/aesthetical components of body representation. This could also potentiate the benefits of psychotherapeutic therapy by decreasing the obsessive drive to lose weight.

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