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Is body perception associated with specific adaptations to static and dynamic tasks?

¿Está la percepción del cuerpo asociada con adaptaciones específicas a tareas estáticas y dinâmicas?

A percepção corporal está associada a adaptações específicas a tarefas estáticas e dinâmicas?

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RESUMEN

Este estudio examinó a las mujeres universitarias en busca de asociaciones entre el perfil somatotipo, la percepción corporal de su propio cuerpo y la percepción del cuerpo de otras mujeres, evaluadas a través de tareas dinámicas y estáticas. Participaron 142 estudiantes universitarios (21.81 ± 3.014 años), evaluados para el índice de masa corporal y el somatotipo por los protocolos de la Organización Mundial de la Salud y Heath-Carter, respectivamente. La percepción de la imagen estática se evaluó mediante la Escala Brasileña de Clasificación de Figuras Fotográficas (BPFRS) y la percepción dinámica de la imagen, mediante la tarea psicofísica Estimación de categoría. Este último se llevó a cabo en dos contextos: percepción del cuerpo mismo y percepción de los cuerpos de cuatro modelos desconocidos. La prueba no paramétrica de Kruskal-Wallis se realizó para el análisis de varianza. Los valores de percepción de imagen dinámica y estática se emparejaron a cero (precisión perceptiva total) y se analizaron mediante la prueba de Mann-Whitney para determinar la tendencia perceptiva. La correlación de Spearman se realizó para detectar asociaciones entre variables. La asociación entre variables categóricas (tareas estáticas y dinámicas) se realizó mediante la prueba de Chi-cuadrado. Se encontró que el perfil del somatotipo no está asociado con la autopercepción estática y dinámica de la imagen corporal o con la percepción de imágenes corporales desconocidas. Aun así, mirar la imagen estática en sí no está asociado con la observación en movimiento, lo que indica que estos procesos de percepción son diferentes e independientes.
Palabras clave: imagen corporal; percepción del tamaño del cuerpo; autopercepción del cuerpo; somatotipo.

ABSTRACT

This study examined university women for associations between somatotype profile and body self-perception, and perception of other women's bodies, in dynamic and static tasks. The sample comprised 142 female undergraduate students (21.81 ± 3.014 years) assessed for body mass index and somatotype by World Health Organization and Heath-Carter protocols, respectively. Perception of static image was evaluated using the Brazilian Photographic Figure Rating Scale (BPFRS), and dynamic image perception, by the Category Estimation psychophysical task. The latter was performed in two regards: body self-image and images of four unknown models' bodies. We performed the Kruskal-Wallis nonparametric test for analysis of variance. Dynamic and static image perception values were paired to zero (total accuracy) and analyzed by Mann-Whitney test for perceptual tendency. Spearman correlation was performed to detect associations between variables. Association between categorical variables (static and dynamic tasks) was by Chi-Square test. Somatotypical profile was found not to be associated with static and dynamic body image self-perception or with perception of unknown body images. Furthermore, looking at one's static image is

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not associated with watching oneself in movement, indicating that these perceptual processes are different and independent of body shape.
Keywords: body image; body size perception; body self-perception; somatotype.

RESUMO

Este estudo examinou mulheres universitárias em busca de associações entre o perfil somatotípico, a percepção corporal do próprio corpo e percepção do corpo de outras mulheres, avaliadas por meio de tarefas dinâmicas e estáticas. Participaram 142 estudantes de graduação (21,81 ± 3,014 anos) avaliadas quanto ao índice de massa corporal e somatotipo pelos protocolos da Organização Mundial da Saúde e da Heath-Carter, respectivamente. A percepção da imagem estática foi avaliada por meio da Escala Brasileira de Classificação de Figuras Fotográficas (BPFRS) e percepção dinâmica da imagem, pela tarefa psicofísica Estimação de Categoria. Este último foi realizado em dois contextos: percepção do próprio corpo e percepção dos corpos de quatro modelos desconhecidas. Foi realizado o teste não paramétrico de Kruskal-Wallis para análise de variância. Os valores de percepção de imagem dinâmica e estática foram pareados a zero (acurácia percetiva total) e analisados pelo teste de Mann-Whitney quanto à tendência perceptiva. A correlação de Spearman foi realizada para detectar associações entre variáveis. A associação entre variáveis categóricas (tarefas estáticas e dinâmicas) foi realizada pelo teste do Qui-quadrado. Verificou-se que o perfil somatotípico não está associado à autopercepção estática e dinâmica da imagem corporal ou à percepção de imagens corporais desconhecidas. Ainda, olhar a própria imagem estática não está associado a se observar em movimento, indicando que esses processos perceptivos são diferentes e independentes.
Palavras chave: imagem corporal; percepção do tamanho corporal; autopercepção corporal; somatotipo.

INTRODUCTION

Body perception involves the ability to estimate body size, both in oneself (Cornelissen & Tovée, 2013) and in others (Sturman et al., 2017). It is elaborated and updated from interactions among sensorial factors (touch, vision, kinesthesia) and non-sensorial factors (beliefs, feelings and thoughts) (McCabe et al., 2006), in processes that most often occur with the experience of movement (Ginis et al., 2014), especially in the context of physical activity (Salci & Ginis, 2017).

Chang et al. (2018) and White et al. (2014) explain that biological motion perception engages specialized brain mechanisms distinct from those used for motion perception more generally. Human body movements reveal a series of attributes, such as emotional states (Vangeneugden et al., 2014), aesthetics (Cazzato & Urgesi, 2012; Smith et al., 2007), gender, identity, physical health, weight (Downing & Peelen, 2016), and notions of body morphology proportionality (Cazzato et al., 2012; O'Toole et al., 2011; Vocks et al., 2007). Sapey-Triomphe et al. (2017) argue that human motion recognition provides information about social interactions, while Krishnan-Barman et al. (2017) and Sapey-Triomphe et al. (2017) consider that action kinematics change depending on social context.

Thus, there is possibly a cognitive category that includes both specific characteristics of one's own body and of other people's bodies (Vangeneugden et al., 2014). That differentiation is important to understanding the elaboration of body perception, that is affected by the experience of body movement and by social context. On the other hand, Preuss et al. (2018) says that motor experiences such as self-orientation perception are influenced by body ownership.

Despite growth in research that uses motion capture and kinematic analysis to examine social and behavioral issues (Krishnan-Barman et al., 2017), these techniques have not yet been deployed to study body image perception, which is still investigated using static, two-dimensional tools, such as silhouette scales (Legenbauer et al., 2011; Vocks et al., 2007). Studies of patients with periodic binge eating disorder (Legenbauer et al., 2011) and bulimia (Vocks et al., 2007) are examples of the few that have investigated static and dynamic body image perception. In both studies, as compared with the control group, subjects affected by eating disorders overestimated the dynamic images more than the static images. These findings suggesting differential importance of motion and shape perception impairments in different clinical disorders (Vangeneugden et al., 2014). However, little is known about dynamic and static body perception in non-clinical samples (Cazzato et al., 2012). Irvine et al. (2019) identified that distortion of body perception may influence the motor schema. If we consider the motor scheme as a motor metric (Irvine et al., 2019) there is a good argument to invest in the evaluation of body perception with more dynamic strategies.

Another gap in research on body image perception is the exclusion of body composition. For Becerra et al. (2013) and Urrutia et al. (2010) body composition is associated with self-perception of health and can be mediated by body image. According to Sturman et al. (2017) is a crucial concept in understanding body size misperception, its associations with body dissatisfaction and the sex differences in these associations. They explained that there are perceptual mechanisms independently sensitive to fat and muscle. The perceptual experience of the body – which, in women, includes perception of health and attractiveness (Brierley et al., 2016; Smith et al., 2007) – depends more on perception of fat than muscle mass (Reigal-Garrido et al., 2014).

In this direction, Castro et al. (2017) when researching the body image of university women included somatotype profile, which expresses relative proportionality between the muscular (mesomorph), adipose (endomorph) and bone (ectomorph) components. The authors identified associations of mesomorphic and endomorphic profiles with body dissatisfaction, body avoidance and negative attitudes to appearance. However, they did not investigate associations between these elements and perceptual dimensions of body image, especially during movement.

Whereas body morphology and perception of movement may interact in body perception (Cazzato et al., 2012), this study aimed to fill two gaps in body image perception research, by including dynamic body evaluation and somatotype as a multicomponent parameter of body composition. It thus sought to examine for: a) differences in the body self-perception when assessed by static and dynamic tasks; b) association between somatotype profile and body self-perception; and c) association between somatotype profile and estimation of others' body sizes. We hypothesized that: 1) there are differences between body perception in static and dynamic tasks; 2) endomorphic and mesomorphic women to be more prone to distorted perception in both task types (dynamic and static) and 3) both situation types (own body, other's body).

METHOD

Participants

From the register of university students on the Rio Claro campus of Paulista State University was sample calculation for finite population was carried out to select participants $N = (Z\alpha / 2\sigma | E)2$[1]. A sample of 142 women (21.81 ± 3 years) chosen randomly was grouped by four somatotype profiles (Carter, 2002): central group (CG, n = 2), endomorph group (ENG, n = 104), mesomorph group (MG, n = 20), and ectomorph group (ECG, n=16). Young women are more susceptible than men to distorted and unhealthy body image thus being more vulnerable to broad impact on their body-related feelings, beliefs and behaviors (Laus et al. 2012; Slevec & Tiggemann, 2011; Reyes-Rincón et al., 2021; Runfola et al., 2013; Swami et al., 2010). Also, studying this group enables our results to be discussed in

[1] N = Number of individuals in the sample, Z α/2 = Critical value corresponding to the desired degree of confidence, σ = Population standard deviation of the studied variable and E = Margin of error or maximum estimate error. Degree of confidence 90%, as α is not known, a value of 0.10 (σ ≈ amplitude / 4) can be assumed (Levine, Berenson. & Stephan, 2000) and the critical value (Z α/2) corresponding of 1,96. To correct the sample size, we used the formula: $N^* = n/1+n/N$: N^* = corrected sample, n= sample obtained by the first formula and N = population size.

comparison with studies in other countries (Swami et al., 2012; Swami et al. 2008).

In order to reduce the effects of factors such as physical exercise, mood, anxiety and so forth about body perception (Cash, Pruzinsky, 2002; McCabe et al., 2006) we excluded people who had: a) exercised in the three hours before the test; b) experienced atypical sleep (insomnia or altered sleep) the night before the test; or c) suffered strong emotion on the day of the test (e.g., bad mood, anxiety, sadness, euphoria, muscle pain or premenstrual tension). Each participant was questioned directly on these criteria before the test.

The Ethics Committee of the Universidade Estadual Paulista - Rio Claro Campus/São Paulo, under Protocol No. 298 and Decision No. 071/2012 approved the study. All participants signed a Declaration of Informed Consent, in compliance with required ethical procedures, according to the Declaration of Helsinki.

Materials and Procedures

Each participant, wearing black shorts and a sleeveless top of Lycra-like adherent material (so as define body outline), had his weight and his self-assessed using, respectively, a Tannita digital platform scale (precision 0.1 kg) and a Sanny stadiometer with movable head (precision 1 cm). These measurements were used to calculate BMI, defined as the ratio of body weight to height-squared. Somatotype was determined based on Heath-Carter instructions (Carter, 2002), which involves ten measurements: height, body mass, four skin folds (triceps, supraspinatus, subscapular and medial calf), two bone diameters (bicepicondylar humerus and femur), two girths (flexed arm in maximum contraction and calf). To calculate each component of endomorph, mesomorph and ectomorph, a specific equation is used (Carter, 2002). All measurements conducted by one measurer trained for this.

Considering that everyone has the three elements of different proportions, the three values must be presented together (endomorph, mesomorph and ectomorph, in that sequence), the classification of the individual being understood as a greater proportion of one element in relation to the others (For example, a somatotype 7-3-1 represents a person primarily endomorphic, who has more adipose tissue in relation to the muscle and bone component). After calculating the three elements, these are plotted in a Franz Reuleaux triangle, which is a two-dimensional graph for obtaining the somatopoint in the somatocarta. The Y axis is larger than the X axis with a ratio of $Y = X / \sqrt{3}$ allowing to represent a three-dimensional image. Thus, the somatochart categorically expresses the proportion between the components of body composition. It is a three-dimensional chart, whose x, y, and z axes, respectively, represent maximum endomorphism, mesomorphism and ectomorphism (Carter, Heath, 1990).

For tasks of this study photographs and films were made using a Sony Cyber-shot camera and were treated and displayed using an HP Pavilion notebook with 14-inch screen and Photoshop CS3 Extended (Adobe®) image manipulation software.

Task 1 – Static Body Perception.

To appraise *Static Body Perception,* we used the Brazilian Photographic Figure Rating Scale (*BPFRS)* (Castro et al., 2016). This tool was selected to be ecological once it considers morphological characteristics of young women and your actual images (Swami et al., 2012) of the appraised in two viewing planes. The participants was photographed from the front, with arms in a neutral position and, from the side, with shoulders slightly extended and legs spread apart to hip width. Thus, using the individual BMI of each participant and following the guidelines of Castro et al. (2016) for each one, a scale composed of 8 juxtaposed silhouettes was built, going from extreme thinness to extreme obesity. This allowed us to calculate frontal and lateral perception indices separately, providing a Frontal Static Perception Index (FSPI) and Lateral Static Perception Index (LSPI) both defined by subtracting the silhouette perceived as representing the actual body from the participant's actual silhouette The value corresponding to zero was parameterized to represent precision in body perception. Positive values indicated overestimation of body size and negative values denoted underestimation of body size. (Castro et al., 2016).

Task 2 – Dynamic Body Self-Perception (DBSP) and Dynamic Perception of Others' Bodies (DPOB). Construction of stimuli and preparation of task.

The methodological apparatus was based, in theory and practice, on psychophysics, which is the same theoretical basis as used for the static task, because it allows detailed, independent evaluation of movement- and form-processing skills, besides being an accessible and practical alternative (Vangeneugden et al., 2014).

We used the Categories Estimation Method, psychophysical task which are presented to the participant a limited number of categories that are equidistant in the psychological continuum. The task consists in pairing categorical stimulus (in our study the somatochart already described) to physical stimuli (in our study the video image), and the corresponding judgments (psychological responses) were assessed from differences between responses to those stimuli (categorical and physical) (Silva & Ribeiro-Filho, 2006).

Previously the participants were filmed from an angle that allowed them to see themselves from the front, in profile and from the back, walking for a stretch of 3 meters. This physical stimulus (video) represents in our research the three-dimensional and dynamic image of the body, where it is possible to observe elements of body morphology different from a photograph. Thus, when the participant judges and combines the categories present in the somatochart with her video, it is possible to investigate internal mental states/representations about the evaluated element, in this case, body perception (Irvine et al., 2019).

Application of the DBSP Task.

The somatochart was presented to each participant with the following instructions: a) "this somatochart graph expresses people's different body types. Each edge represents extremes of obesity, muscularity, and thinness. The body profile that balances muscle mass, fat and bone density is located at the center"; b) to ensure that participants understand the theory behind the instrument, we show them the 7-4-2 point and ask them to say what proportionality among the components it represents. We expect them to respond that this point represents a person who has, primarily more fat tissue, followed by muscle, and being short in stature. If the answer is discrepant, it is explained again. There were no cases of such complete misunderstanding of the task as to require replacing the participant.

After the participant viewing her video was asked: a) *"after watching your video locate the somatopoint on the* somatochart *that best represents your real body"* (perceived somatopoint); b) *"Choose the somatopoint on the somatochart that best represents the body that you would like to have"*. No limit was placed on video viewings because we believe this does not affect the task.

Application of the DPOB Task.

Previously four female models representing each of the four extreme somatotype profiles (endomorph, mesomorph, ectomorph and central) and who were not known to the participants were also filmed and were shown separately, and participants were then given the instruction: *"After viewing this video, locate the point on the* somatochart *that you believe best represents that person's body profile"* (perceived somatopoint).

Assessment of body perception (DBSP and DPOB).

For our analysis, we were interested in knowing the discrepancy between the perceived somatopoint by the participant and the real somatopoint, both regarding her own body and the models' body. Since somatopoint is a relation between three numbers, the strategy adopted to evaluate body perception with this task was by

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calculating Somatotype Positional Distance (SPD), which gives the three-dimensional distance between two somatopoints (Carter, 2002). The SPD represents the real distance in three-dimensional space between two points, A and B, as calculated by equation: SPD = $\sqrt{}$ (IA – IB)^2 + (IIA – IIB)^2 + (IIIA – IIIB)^2 (Carter, 2002). Where: I, II and III are values equivalent, respectively, to endomorphy, mesomorphy, and ectomorphy. The sub-indices A and B provide indications of two somatotypes to be compared, in our case, to the somatopoint perceived by the participant (A) and the participant's real somatopoint (B).

Analogous to BPFRS (Castro et al., 2016), it can be inferred that the higher the SPD value, the greater the difference between the somatotypes compared, where zero is perfect equivalence or perceptual accuracy. In our study, this value translates into the dynamic perceptual index. The same procedure was applied to appraise perception of model's body.

Like this the variables in this study were thus: a) *dynamic body self-perception (DBSP); b) dynamic perception of others' bodies (DPOB); c) frontal static perception index (FSPI); and d) lateral static perception index (LSPI*).

Psychometric Qualities of the DBSP.

Validity and temporal stability are two requisites for a tool to be useful for research or in clinical practice (Cash, 2011; Thompson, 2004). Thus, following guidelines from Alexandre and Coluci (2011) and Pasquali (2003) was examined for content validity, criterion validity, and temporal stability for to verify the psychometric qualities of the dynamic body perception task

Content validity.

Fifteen expert judges, invited to assess the dynamic body perception task content validity. ten of them had been specialists for at least 5 years in in body image and psychometric research the other 5 were experienced psychophysical experts. All experts received a form on which they were required, after viewing the dynamic body perception task, to assign values of one (strongly disagree) to five (strongly agree), to indicate their level of agreement with five key affirmations:(a) the elements that make up the task (videofilming and somatocarta) are consistent with the human body characteristics; (b) the task is visible, practical, and easy to apply; (c) the task is capable of evaluating dynamic body perception; (d) the videofilming represents the female body in a realistic, three-dimensional and dynamic way; and (e) videofilming allows the identification of morphological elements of the individual's body. Data were analyzed descriptively. In keeping with the value commonly adopted in the literature (Hair, Black, Babin, & Anderson, 2009), we sought at least 70% interrater agreement (at least eleven judges) with high ratings of instrument approval, ratings of 4 (agree) to 5 (strongly agree) for each dimension assessed.

Criteria validity.

Was tested by examining correlations between: a) participant's actual somatotype profile and the characteristic somatotype profile the participant chose to represent her body; and b) the somatotype profile chosen to represent the participant's body and her body dissatisfaction index (calculated as the difference between the somatotype profiles representing the participant's actual and desired bodies). Positive correlations were expected between these variables.

Temporal stability.

The instrument's stability and reproducibility of results (Agresti, 2013) was assessed by retesting 30% of the sample (Thompson, 2004). Note that static and dynamic tasks were set on different days, and the test-retest interval was 35 days. Significant positive associations between test and retest results were expected.

Statistical data analysis

Descriptive data analysis was expressed in central tendency and dispersion values. On examination by the Kolmogorov-Smirnov test, the variables did not meet the normal distribution criterion ($p > 0.05$). Accordingly, non-parametric analysis was performed using the Kruskal-Wallis test for analysis of variance, to determine whether dynamic body self-perception (DBSP) and dynamic perception of others' bodies (DPOB) differed by somatotype profile. To examine for association among the categorical variables (somatotype, FSPI and LSPI), the Chi-square test was performed. Also, the values of DBSP, DPOB, FSPI and LSPI were compared to the zero value (total accuracy) and analyzed by the Mann-Whitney test for independent samples to assess the dynamic and static body perception. Lastly, content validity testing entailed descriptive analysis of percentage of agreement, the Spearman correlation was performed to detect associations between the variables, and the instrument's temporal stability was analyzed using the Kappa Cohen coefficient of agreement (Agresti, 2013). All analyses were performed using SPSS software, v. 18.0 (SPSS Inc., Chicago, IL, USA) to a 5% level of significance.

RESULTS

In the assessment of the task' performance in evaluating dynamic body perception, content validity, judges' scores expressed high approval ratings with interrater agreement in excess of the previously established criterion of 70% (Hair et al., 2009). Significant positive correlations were found between participants' actual and perceived somatotypes (rho = 0.67; p < 0.0001), demonstrating correspondence between these variables. Similarly, high correlation was found between endomorphic profile and body dissatisfaction (rho = 0.77; p < 0.0001). Temporal stability between test and retest scores was tested by significant positive correlations for DBSP in assessing body perception (rho = 0.63; p < 0.0001). The Kappa index indicated moderate temporal stability for the DBSP in assessing body perception (κ = 0.581; p < 0.0001) (Agresti, 2013).

Considering that the zero value represents accurate body perception, it was possible to establish that participants were generally more accurate in their perception of static images (FSPI and LSPI) (Table 1). Table 2 shows that, in more than 50% of the sample, there was a tendency to overestimate, although some subjects showed accuracy and underestimation in their body self-perception.

Table 1: Means and standard deviation of the values obtained in each of the variables

Dependent variables	**Groups**				
	CG*	***ECG****	***ENG****	***MG****	***TOTAL***
DBSP #	2.6 ± 0.3	2.8 ± 0.7	2.3 ± 1.1	2.7 ± 4.9	2.4 ± 1.2
DPOB ##ENDO	5.8 ± 1.1	4.8 ± 1.0	4.9 ± 0.9	4.6 ± 1.0	4.9 ± 1.0
DPOB MESO	3.1 ± 1.9	2.0 ± 2.0	2.8 ± 1.1	2.6 ± 1.0	2.7 ± 1.1
DPOB ECTO	1.8 ± 0.3	2.3 ± 0.8	1.9 ± 0.6	2.9 ± 1.1	2.0 ± 0.7
DPOB CENT	2.3 ± 0.5	2.5 ± 0.7	2.5 ± 2.5	2.4 ± 0.8	2.5 ± 0.8
FSPI °	2*	0	1*	1*	1
LSPI °°	2*	0	1*	1*	1

Dynamic Body Self-Perception ## Dynamic Perception of Others' Bodies (values expressed as mean and standard deviation) ° Frontal Static Perception Index – °° Lateral Static Perception Index (values expressed as median) * Significant difference in relation to the total accuracy value (zero) (p < 0.05)

No statistical interaction between groups was observed in any of the dynamic task situations: DBSP H (3) = 3.4, p = 0.3), and DPOB ENDO H (3) = 3.2; p = 0.3), DPOB MESO H (3) = 6.4; p = 0.9); DPOB ECTO H (3) = 4.4; p = 0.2), DPOB CENT H (3) = 0.4; p = 0.9). There was also no statistically significant association between somatotype profile and static body self-perception for either frontal image view FSPI $\chi 2$ (6) = 6.635 (p = 0.35) or lateral image view LSPI $\chi 2$ (6) = 8.340 (p = 0.2). This indicates that perceptual behavior was not influenced by participant's somatotype profile in either of the two tasks (dynamic and static body self-perception and perception of another woman's body). When the values of the variables were compared to the total accuracy value (zero), significant differences were demonstrated ($p < 0.05$) for all groups in both tasks. The exception was the ECG, which returned no significant difference ($p = 0.42$) between the measured score and the total accuracy score in the static perception task. In summary, there was a general perceptual tendency to overestimate in both static and dynamic tasks regarding both body self-perception and perception of an unknown body.

Table 2: Relative frequency and absolute perceptual accuracy

Variables	n	%
Frontal Static Perception Index – FSPI		
Accurate	48	33.8
Underestimated image	14	9.9
Overestimated image	80	56.3
Lateral Static Perception Index – LSPI		
Accurate	43	30.28
Underestimated image	20	14.08
Overestimated image	79	55.63

Spearman correlation between the study variables showed that there is an association between FSPI and LSPI (rs = 0.7; p = 0.0001). On the other hand, there was no association between DBSP and either FSPI (rho = 0.01; p = 0.8) or LSPI (rho = -0.1; p = 0.1). This demonstrates that there are differences between perceiving the body through static images (i.e., in photographs) and in motion (i.e., in video).

DISCUSSION

This study examined whether university women's somatotype profile displayed associations with their body self-perception and perception of other women's bodies in dynamic and static tasks. Our hypothesis that participants with endomorph and mesomorph profiles were more prone to distorted perception than the other groups was rejected, since somatotype profile did not associate with body self-perception and perception of the other's body. All groups tended to overestimate their own body dimensions in the static and dynamic tasks. The only exception was the ectomorph group in the static task, where the values returned were close to the norm (zero, equivalent to perceptual accuracy).

Our hypothesis was anchored largely in the findings of Sturman et al. (2017), which suggested that the neural mechanisms involved in body fat and muscle perception are processed independently. In this connection, they confirmed that visual adaptation provides a model of body size misperception and suggested that this model may be applicable to manifestations of body image disturbance related to ideals of thinness and of muscularity. We believe that the difference between our research and that of Sturman et al. (2017) lies in two methodological facts: the theory paradigm used to investigate body perception, and the segmentation strategy of body composition.

Sturman et al. (2017) took a neurological approach, examining for neural correlates with perception of the two different components of body composition. This study, on the other hand, used the psychophysical paradigm (Silva and Ribeiro-Filho, 2006) to investigate the perception of the body (Irvine et al., 2019) from the behavior (Vangeneugden et al., 2014). While Sturman et al. (2017) used a two-compartment (fat and muscle) model of body composition, we used a three-dimensional model with a notion of proportionality, without emphasizing any component. Thus, although Sturman et al. (2017) demonstrated that differential neural sensitivity is involved in fat and muscle perception, this did not extend to endowing the behavior observed in our research with the ability to change body perception.

Brierley et al. (2016) and Smith et al. (2007) have already explained that, when perceptual evaluation focuses on elements such as attractiveness and health, perception of body shape and size is influenced more by perception of body fat than muscle mass. They emphasize the importance of including body composition in body image studies.

Researching obese populations with and without binge eating disorder, Legenbauer et al. (2011) found that, in static tasks to evaluate body perception, perceptual aspects are more influenced by attitudinal factors than by body weight. On the other hand, Vocks et al. (2007) and Vocks et al. (2010) explained that the opposite occurs when body perception is assessed through dynamic tasks.

Our expectation was that perceptual and attitudinal aspects of body image would be similarly associated with the somatotype profile, because recently Castro et al. (2017) demonstrated that body dissatisfaction, body avoidance and negative attitudes to appearance components were linked to each other and influenced by (predominantly mesomorphic and endomorphic) body profiles.

Although this study did not evaluate attitudinal aspects, these may have interfered in the results, since routine perceptual experience (both self-perception and perception of others' bodies) can modulate aesthetic appreciation (Mele et al., 2013), which is influenced by body size, as with slim bodies for women (Cazzato et al., 2012). We suspect that this is perhaps the reason why the perceptions of the ectomorph group were more accurate in the static task: by virtue of its proximity to what is considered the standard Western ideal of beauty. Similarly, Castro et al. (2017) found that ectomorph was associated with lower negative impacts on attitudinal aspects of body image. From a neurophysiological standpoint, Sturman et al. (2017) explained that, although with no statistical significance, bodies with extreme body fat levels principally adapt neurons that are tuned to respond to fat, but also, to a lesser degree, they adapt muscle-related mechanisms. Yet bodies that are low in muscle do not adapt fat-related mechanisms. Indicating that there is a relationship between sensorial and non-sensorial aspects in elaboration of body image perception (McCabe et al., 2006).

It is thus possible to infer that body self-perception involves specific neural (Sturman et al., 2017), perceptual and attitudinal elements enmeshed with one another and that, depending on the task proposed (Ambroziak et al. 2019), that is, whether the focus of perceptual evaluation involves aesthetic appreciation (Cazzato et al., 2012; Mele et al., 2013), attractiveness (Brierley et al., 2016; Cazzato et al., 2014) or body dimensions (as in the case of this study), body composition will influence perceptual accuracy. This fact has recently been proven by Irvine et al. (2019) in research that points that distances between perceived versus actual body size were associated with body parts that had larger variations in adipose/muscle-dependent circumference.

Ambroziak et al. (2019), using the theory of visual adaptation in static tasks, investigated whether exposure to extreme body types affects the perception of one's own body and of other people. Like our results, the authors found the same tendency for judgments of one's own body regarding the body of the other. This suggests that adaptation to body size has no effect especially on body self-image. Interestingly, in dynamic tasks, perception of other women's bodies followed the same tendency as body self-perception: body sizes of models unknown to participants were also overestimated. Chang et al. (2018) explain that perception of biological actions is mapped into the observer's own motor representations. It is thus possible that each participant used their own body as a parameter for measuring other women's body sizes.

Brooks et al. (2016) argue that the neural mechanisms responsible for encoding body size for one's own body and others' bodies show a degree of overlap. In cases of body image disorders, they found that adaptation to thin others causes observers to regard their own objective bodies as larger than normal, which corresponds to the established, real-world phenomenon. Taken together with our results, this explanation leads us to suggest that, in the dynamic task of evaluating others' bodies, attitudinal aspects had less influence than perception of form.

Curiously the size of the endomorph model was perceived as much larger than it was, although with no significant differences between the somatotype profile groups. Similar results were found by Cazzato et al. (2012), who also detected that extremely thin models were judged as leaner still. There thus seems to be a tendency to accentuate extreme sizes. The authors argued that aesthetic appreciation of body shape and size cannot be explained by physical structure and body proportionality alone, but also involves the emotions evoked by movement. In addition, when viewing movement as compared with static images, there is a "social intention" bias capable of altering neural activity and consequently perceptual sensitivity (Roché et al., 2013).

Vocks et al. (2010) noted that previous studies had shown that, when women with anorexia and bulimia analyzed other women's body shapes, they displayed strong activation of the limbic system, possibly resulting from social comparison processes. Thus, they argued, when participants reflected on their own attributes, they reflected on the physical appearance or personality traits of the other person with whom they were comparing. In this regard, Brooks et al. (2016) emphasized that there is a reciprocal cross-adaptation effect: "the effect transfers from exposure to others' bodies affecting the perception of one's own body, and from exposure to one's own body influencing the perception of another's body". This fact further justifies the need to extend our knowledge not only of how people perceive their own bodies, but also of how they perceive the bodies around them.

Our last finding confirms our hypothesis: front and side static body perception highly correlated, but static and dynamic perception were not. From a neurophysiological standpoint, the literature is consistent in claiming that perception of form and movement are processed at different sites in the brain (Cazzato et al., 2014; Chang et al., 2018; Downing & Peelen, 2016; O'Toole et al., 2011; White et al., 2014). Like Vangeneugden et al. (2014), we sought an alternative to brain scanning strategies and, by applying the psychophysical paradigm, were able to confirm this fact.

Although the findings of Vangeneugden et al. (2014) demonstrated functional separation between form and motion processing, and our research showed that perception in static and dynamic tasks is not associated, both found overestimation of body size. However, we cannot explain what mechanisms mediated perceptual behavior in both tasks; this is still an intriguing question. In fact, in practical life we know that there are different impacts when we see ourselves in a photograph (albeit at different angles) when compared to a dynamic image such as a film or even in the mirror. This can be attributed to the fact that in dynamic images extra information on depth, texture, contours, and others are available (Smith et al., 2007). Nevertheless, if we are dissatisfied with our image in a photo, we will probably feel the same in the dynamic image.

Such thinking has led researchers to believe that the experience of movement present in physical activity and sports can positively impact body image (Ginis et al., 2014; McIntyre et al. 2015; Salci & Ginis, 2017). Roché et al. (2013) explained that people are skilled at detecting and differentiating social intentions that are present in movements and not in static images. Because of this, in the former situation, visuospatial attention is focused on the trunk and, in the latter, on the extremities. Considering that information about body size is concentrated in the trunk region, this may explain why the values returned in our dynamic task were further from the norm (zero) than in the static task.

As in this study, Legenbauer et al. (2011) and Vocks et al. (2007) also found significant differences between static and dynamic tasks, although their samples were clinical. They argued that static body image is associated more with preoccupation with form, weight and desire to lose weight, whereas dynamic image perception associates with insecurity and avoidance. They emphasize that, although these variables are related, the relationship is not causal.

Thus, Vangeneugden et al. (2014) and White et al. (2014) explained that the difficulty in evaluating and interpreting perceptual processing of static and dynamic images lies in the fact that these are closely integrated. O'Toole et al. (2011) pointed out that the most accurate human identification judgments come from the combination of static face perception and dynamic whole-body perception. One practical implication of this is that populations with clinical disorders (i.e., eating disorders) display significantly greater deficiencies in perception of movement and form (Vangeneugden et al., 2014). Hence the importance of studying both static and dynamic body image perception.

In short, we believe that a broad understanding of the perceptual dimension, involving body composition, as well as static and dynamic body self-perception, is fundamental to refining research into body image, especially where there is a relationship with physical activity, since experimental studies have shown that this is capable of fostering positive changes in body image (Ginis et al., 2014; McIntyre et al., 2015; Salci & Ginis, 2017). In addition, Preuss et al. (2018) pointed out that the sense of body ownership determines the perceived self-orientation as well as self-motion perception. This argument was recently reinforced when Irvine et al. (2019) have demonstrated that the body schema which program the egocentric body movement uses the body perception to update sensory/proprioceptive/kinesthetic information and consequently to update the stored body representation.

There were limitations to this study that should be mentioned. Although the psychophysical paradigm adopted provided a theoretical basis that allowed body shape and perception of body movement to be assessed separately, thus contributing to future research to provide information on functions preserved and affected in pathological populations (Vangeneugden et al., 2014), that approach does not enable social attributes to be eliminated, which may hamper separation of perceptual and attitudinal aspects (Legenbauer et al. 2011). Furthermore, although the tool proves to be reliable, valid and stable (Castro et al., 2016; Swami et al., 2012), care should be taken when interpreting central tendency analyses applied to silhouette scales (Gardner, 2011), at the risk of arriving at misleading conclusions about body perception in the sample.

Another limitation was that the sample comprised only women. This is important, because prior studies have indicated gender-related hemispheric asymmetry in body perception processing (Cazzato, et al., 2014). Finally, the small sample size and the numerical imbalance among groups also restrict generalization. We are aware of these limitations and encourage researchers fill the gaps.

CONCLUSIONS

This study demonstrated that somatotype profile does not influence university women's static and dynamic body self-perception or their perception of other women's bodies. Seeing oneself in a static image was found not to correlate with seeing oneself in motion, which indicates that the perceptual processes involved are different. However, such interpretations and generalizations require caution, because this research must be considered exploratory and should be replicated in larger samples, including males and other age groups.

PRACTICAL IMPLICATIONS

This study endeavors to extend the discussion of issues relating to dynamic perception of the human body, and how it influences elaboration of body image, which thus far have focused on only the ethnic, aesthetic and attractiveness aspects of body perception. The study also explored the impact of the notion of body proportionality on body perception. We strongly recommend that the dynamic dimension and body composition be incorporated into research into body perception, so as to render evaluations more ecological. In Brazil, there is still a gap in studies of the perceptual dimension of body image, which sometimes forces us to base our practices on studies of other populations with different cultural and physical characteristics. We suggest that the theme body image be inserted from the early school years in classroom and extracurricular activities, in the form of body activities, primarily in natural environments (Reyes-Rincón et al., 2021), drawings and debates. The main justification for this refers to the fact that in children and adolescents the body image is closely associated with self-perception of health and engagement with sports and physical activity (Ceballos-Gurrola et al., 2019; Urrutia et al., 2010) and physical condition (Blanco et al., 2017; García-Sánchez et al., 2013). Thus, this study thus did provide, albeit succinctly, a methodological alternative and information about perceptual accuracy among university women that can easily be incorporated into future research.

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