Rank-Order of Body Shapes Reveals Internal Hierarchy of Body Image

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Abstract: How do individuals rank body shapes? Does this relate to the body part one is most dissatisfied with? Our study investigates whether one can generalize regarding how women represent the body. Three BMI-calibrated images from the Photographic Figure Rating Scale, representative of thin (BMI = 14.72), medium (BMI = 20.33), and large (BMI = 29.26) shapes, were divided into torso, legs and arms, and saved as individual images on a black background. Of 27 possible composite images, 8 were chosen based on a Torso (thin vs. large) × Leg (thin/large vs. medium) × Arm (thin vs. large) design. Our 44 female participants ordered these from thinnest to largest. This was first according to torso, then leg, and finally arm: 41 individuals agreed on the thinnest image (thin torso, thin legs, thin arms), followed by a second image (thin torso, thin legs, large arms, n = 26; or thin torso, medium legs, thin arms, n = 10). One participant differed markedly in her choice of the first image (large torso, medium legs, thin arms). Interestingly, she scored 10 on the EDI-2 scale of Bulimic Tendencies, revealing high risk for bulimia, suggesting that our task might be useful for studying eating disorders. Our juxtaposition of two analytic procedures—partial order scalogram analysis (POSAC) and cluster analysis—enables one to uncover such outliers in a data set. Importantly, the 2D POSAC space clearly reveals the hierarchical structure of the body image.

Keywords: Body image; Photographic Figure Rating Scale; eating disorders; POSAC; cluster analysis.

Introduction

While the notion of the body image resonates with a gestalt (Werner, 1965), it is nevertheless the case that women who are dissatisfied with the way they look tend to spend more time inspecting particular regions of the body (Svaldi et al., 2016). For example, a female misperception of being spatially larger can be localized to the region of the torso (Gendebien & Smith, 1992). Those having an increased drive for thinness (DT) will focus on the waist, arms, hips and legs (Hewig et al., 2008). In fact, DT is often related to body dissatisfaction (Jones et al., 2014; Keski-Rahkonen et al., 2005), and empirical evidence suggests that body image disturbances are a pivotal etiological and maintenance factor of eating disorders (Ghaderi & Scott, 2001; Stice, 2002).

Given this, what is the internal hierarchy of the body image? Does one focus on the extremities (legs, arms) prior to more central regions (head, torso)? Or, does one move outwards from the center? Certainly, areas of focal interest would include the torso (Irvine et al., 2019), the legs, and the arms (Rodway et al., 2018). The torso (specifically, the chest) is perceived as being more significant than either the arm or the leg (Morrison & Tversky, 2005). Further, is there a point of reference when an individual indicates their real/ideal body shape? Presumably, this would be with respect to one's own BMI[1] (McCabe, Ricciardelli et al., 2006,

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[1] Body Mass Index (weight divided by height-squared), expressed in kg/m^2.

p. 164). In this study, we had two specific aims: (1) to investigate the hierarchical structure of the body image using a rank-ordering task of specifically constructed body shapes; and (2) to present two analytical procedures that, when used together, enable us to portray this structure in a 2D representational space.

To investigate this rather neglected area of research, we employed images taken from the familiar Photographic Figure Rating Scale (Swami et al., 2008a, 2008b). These were divided into torso, legs and arms, from which we could construct composite images for our participants to inspect, and then to rank-order these from the thinnest to the largest body shape. A rank-ordering, or card-sorting, task has previously been employed to uncover the hierarchical structure of a data set (Avital & Cupchik, 1998), and to "allow the natural structure of conceptual systems to emerge" (Gabe-Thomas et al., 2016, p. 3). With respect to the body image, such a task has been employed to order female body photographs in terms of increasing BMI (Schuck, Munsch, & Schneider, 2018), and to order various body parts (e.g., arm, leg) in terms of significance (Morrison & Tversky, 2005, pp. 700-701). Hence, the purpose of this rank-ordering task in our study is to uncover the hierarchical structure of the body image.

How should one analyze such rank-ordering data? In ordering the images from thinnest to largest, an individual profile is generated. The set of profiles created will be analyzed using both cluster analysis (Vargha et al., 2016) and scalogram analysis (Shye, 2007), and subsequently the cluster-analytic solution will be superimposed on the scalogram space. Given the fact that one of our participants exhibited markedly aberrant performance on the task, this juxtaposition of analytic procedures will serve the additional diagnostic goal of uncovering outliers in a data set.

Method

Participants and design

Forty-four female undergraduate university students participated in this study on a voluntary basis. They signed an informed consent form, and the study was approved by the ethics committee of Bar-Ilan University. They were randomly assigned to one of four groups each containing 11 participants (see below). This sample size and group allocation is comparable to that recently reported by Irvine et al. (2019) when assessing body image. If 20-30 participants are sufficient for a rank-ordering study (Gabe-Thomas et al., 2016, p. 4), then, again, our sample size should be adequate.

Measures

We employed three scales taken from the *Eating Disor-

der Inventory-2* (EDI-2; Garner, 1991), which is one of the most widely used self-report questionnaires for assessing psychological characteristics related to ED pathology among Western populations (Garner, 1991; Strien & Ouwens, 2003). These were Drive for Thinness (DT); Bulimic Tendencies (B); and Body Dissatisfaction (BD). Following Garner's instructions, item-responses ranging from 1 to 6 are forced into a 4-point scale, with the most extreme anorexic response earning a score of 3, the highest-but-one response receiving a score of 2, the next response being awarded 1, and the three least "anorexic" responses all receiving a score of 0 (transformed item scores). Weight and height were self-reported, as part of the EDI-2 questionnaire. In addition, the participant was asked which part of the body she was most satisfied with and which part she was most dissatisfied with.

The Photographic Figure Rating Scale (PFRS) measures Body Dissatisfaction, and for our purposes Body Image. The participants are asked to choose which figure represents their current body image (B), and which figure represents their ideal body image (I). The 10 PFRS images are calibrated with BMI, as follows: Image 1 (BMI = 12.51); Image 2 (BMI = 14.72); Image 3 (BMI =16.65); Image 4 (BMI = 18.45); Image 5 (BMI = 20.33); Image 6 (BMI = 23.09); Image 7 (BMI = 26.94); Image 8 (BMI = 29.26)[2]; Image 9 (BMI = 35.92); Image 10 (BMI = 41.23), as reported by Swami et al. (2008b). We distinguish between body size distortion, which contrasts current body image (B) with actual body image (this distortion is concretized here as the discrepancy between the BMI for B and self-reported BMI), and body size dissatisfaction, which contrasts B and ideal body image (I).

Standard presentation of these images is in ascending order from left to right. Furthermore, first B is indicated, and then I. In the present study, we employed two orders of presentation: ascending (a) and descending (d). We also presented the two tasks (B, I) in two orders. Crossing these two factors of Order of Presentation and Task resulted in 4 series of tasks, each presented to a separate group of 11 participants: Group 1 (Ba, Bd, Ia, Id); Group 2 (Bd, Ba, Id, Ia); Group 3 (Ia, Id, Ba, Bd); and Group 4 (Id, Ia, Bd, Ba).

In controlling for the order of presentation of the images, we can address the question of whether in viewing the descending series, our participants "will reach a final judgment of their body size that is too large", while when viewing the ascending series, they "will reach a final judgment that is too thin" (Gardner & Brown, 2011, p. 741). In controlling for the order of presentation of the two tasks (B, I), we can address the requirement that separate presentation orders are needed when participants make "current and ideal figure ratings" (Swami, Cavelti, Taylor, & Tovée, 2015, p. 32).

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[2] And yet, Swami et al. (2008a, p. 226) report for this same image a corresponding BMI value of 34.26.

Rank-Ordering Task

Image 2 (BMI = 14.72), Image 5 (BMI = 20.33), and Image 8 (BMI = 29.26) of the PFRS were manipulated using Adobe Photoshop, set to 600 pixels per square inch for all stages. These images, which are equidistant on the PFRS, were chosen to be representative of thin, medium, and large body shapes. Each was divided into torso, legs, and arms, and these body parts were saved as individual images (130 mm × 130 mm). These isolated body parts were used to construct 27 composite images, each placed on a black background, and slightly edited to appear more real. Seven of these images were eliminated due to their grotesque nature (i.e., the particular composite image is blatantly malformed). From the remaining images, a total of 8 were chosen for the rank-ordering task, based on a Torso (thin vs. large) × Leg (thin/large vs. medium) × Arm (thin vs. large) design. These images appear in Figure 1. The images were printed on separate cards. These were presented to the participant in a random order (achieved by shuffling the cards before the participant). The task presented to the participant was to order the images from thinnest to largest.

Procedure

The participant first completed the 4 PFRS tasks in the order determined by her group affiliation. She then completed the rank-ordering task. At the end of the session, she completed the EDI-2 scales, printed as a questionnaire.

Analytical Procedures

We employ two analytical procedures for investigating the hierarchical structure of our rank-ordering profile data. One is cluster analysis, which groups the various profiles into clusters, such that the basis for forming the clusters (e.g., a similar focus on the torso in our data), the number of clusters (e.g., torso, legs, etc.), and their linkage indicate how the body image is represented. The other is partial-order scalogram analysis, which maps these profiles into a 2D representational space, such that the basis for partitioning this space (e.g., a dimension of center-extremities in our data) indicates whether the body image has a unidimensional mapping or requires two dimensions, and what those dimensions reflect in the data. By embedding the cluster-analytical solution within the 2D representational space (e.g., Shepard, 1980), a better understanding of the hierarchical structure of the body image will be obtained.

Figure 1.

The 8 images used for the rank-ordering task. Image 1 (= thin torso, thin legs, thin arms); image 2 (= thin torso, thin legs, large arms); image 3 (= thin torso, medium legs, thin arms); image 4 (= thin torso, medium legs, large arms); image 5 (= large torso, large legs, thin arms); image 6 (= large torso, large legs, large arms*); image 7 (= large torso, medium legs, thin arms); and image 8 (= large torso, medium legs, large arms).*
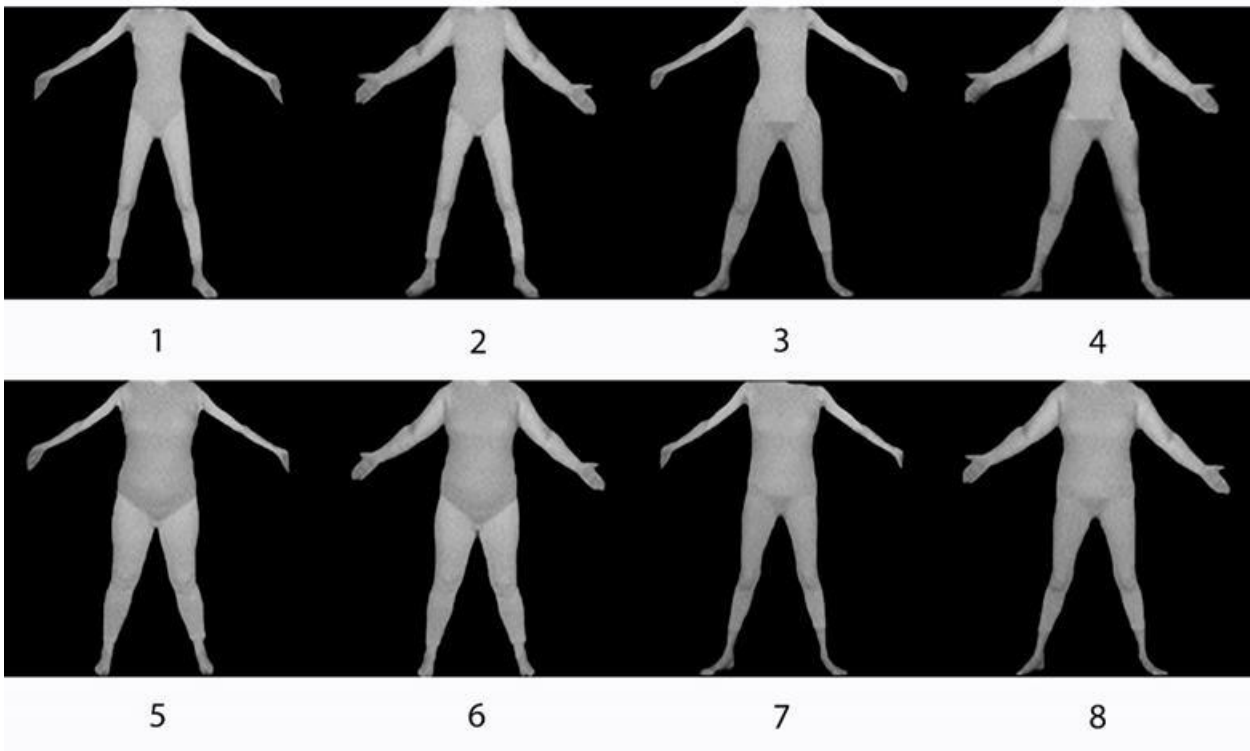
Note. *indicates a non-modified image taken from the *PFRS*.

Results

Performance on the PFRS

Current, or perceived, body image was uniformly higher in BMI than ideal body image [$F(1, 39) = 32.42$, $MSE = 1.52$, $p < .0001$], as can be seen in Figure 2, which is as one would expect, and this effect is not moderated by Group (as defined by crossing task with order of presentation) [$F(3, 39) < 1$]. Furthermore, the higher the participant's BMI, the more apparent is this discrepancy (on average).

Figure 2.
Body image and ideal image as a function of BMI.
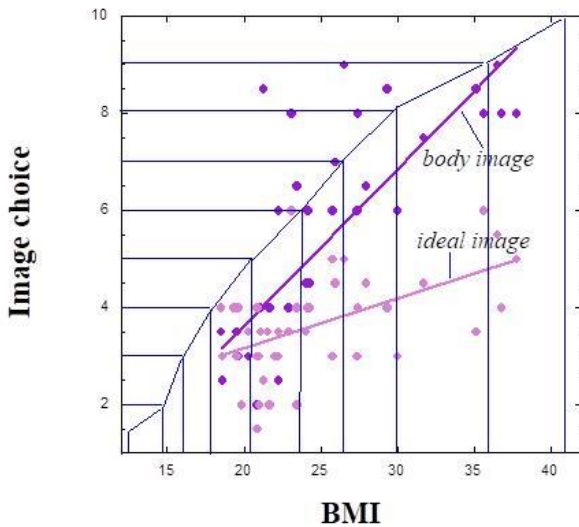
Performance on the ascending and descending series is highly correlated for both perceived body image ($r = .94$, $p < .0001$) and ideal body image ($r = .72$, $p < .0001$), and the discrepancy score (i.e., the difference between these respective means) between the two series is practically zero for both perceived and ideal body image [$t(43) < 1$ for both].

Performance on the rank-ordering task

Rank-ordering of body image from thinnest to largest was practically monotonic [$F(7, 301) = 55.07$, $MSE = 2.69$, $p < .0001$], as can be seen in Figure 3. On looking at the individual profiles, we note that 41 of our 44 participants agreed on the thinnest image, this being image #1 (thin torso, thin legs, and thin arms). Figure 4 presents the modal number of choices made for each image, and as can be seen, ordinal choice preserves an inner hierarchy of first (thin) torso (images #1, #2, #3, and #4), then (thin) leg (images #1 and #2), and finally (thin) arm (images #1, #3, #5, #7).

Figure 3.
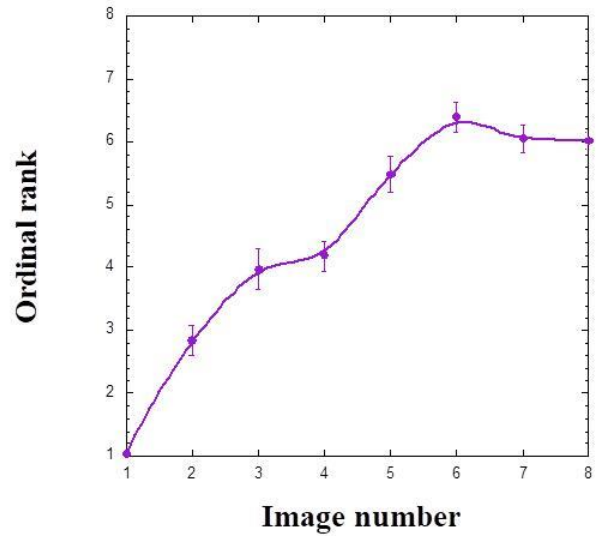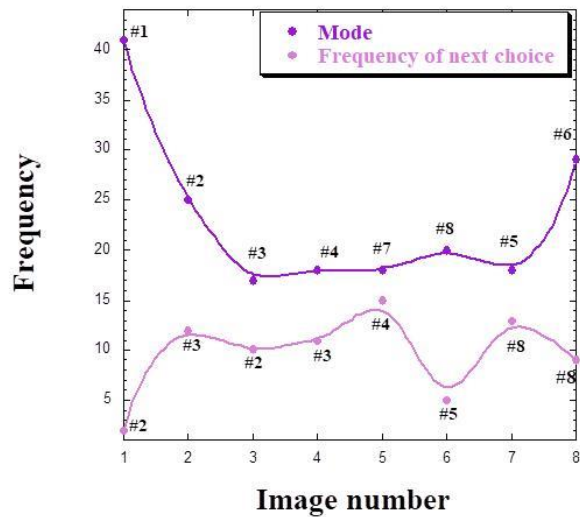*Ordinal ranking of images (from thinnest to largest).*

Figure 4.
Modal choice of images.

Aberrant performance on the rank-ordering task

Three participants did not agree with the others on the thinnest image (i.e., thin torso, thin legs, thin arms—see Figure 1). These were participants #34 and #40, both of whom placed image #2 (i.e., thin torso, thin legs, large arms; see Figure 1) in first rank order of thinness. Even given this discrepancy, the hierarchical order of first torso, then legs, is preserved. In contrast to these, participant #11 chose image #7 as being the thinnest. This image (i.e., large torso, medium legs, thin arms; see Figure 1) is clearly deviant, as is the participant herself, who scored 10 on the EDI-2 scale of Bulimic Tendencies, revealing high risk for bulimia, suggesting that our task might be useful for studying eating disorders.

Profile analysis

Given the nature of our rank-ordering task, the individual profile generated necessarily presents correlated choices. To alleviate this situation, we shall look at only the first five ratings, and submit this truncated profile to cluster analysis. Even though the data are clearly ordinal in nature, cluster analysis can still be employed here (Mooi, Sarstedt, & Mooi-Reci, 2018, p. 337). Figure 5 presents the dendrogram obtained for the top four branches of the clustering solution provided by Stata, on implementing Ward's hierarchical method (using the squared Euclidean distance metric); Table 1 provides summary statistics provided by the clustering module of ROPstat (Vargha, Torma, & Bergman, 2015), when employing Ward's method followed by a k-clustering tweaking of that cluster solution, for k ranging between 2 and 6. For $k = 4$, the same four clusters are uncovered; at this level, $ESS > .67$ (Malmberg & Little, 2007, p. 744) and $HC < 1$ (Malmberg & Little, 2007, p. 744; Vargha et al., 2016, p. 81)—all of which support the $k = 4$ cluster solution.

In line with a reviewer's suggestion that, in addition to using Ward's method, we implement a different clustering algorithm to confirm the 4-cluster solution, we employed both the single-linkage and complete-linkage algorithms in ROPstat (for both using squared Euclidean distance, as before), followed by the k-clustering tweaking of the cluster solutions, as before. These two specific clustering methods were employed in line with the suggestion that "single or complete linkage would be preferable to Ward's method when the data are ordinal" (Blashfield, 1976, p.

386), as indeed is the case with our data. Table 2 summarizes the results of these analyses.

As before, for $k = 4$, $ESS > .67$ and $HC < 1$. We note that it is the specific implementation of a hierarchical clustering method, followed by a k-clustering tweaking of the solution (Bergman, Vargha, & Kövi, 2017, p. 52) that leads to this convergence in solutions. Without the follow-up tweaking of the solution, there would be a discrepancy in the results, though as Vargha et al. (2016, p. 79) note, "good algorithms tend to produce similar findings."

Figure 5.
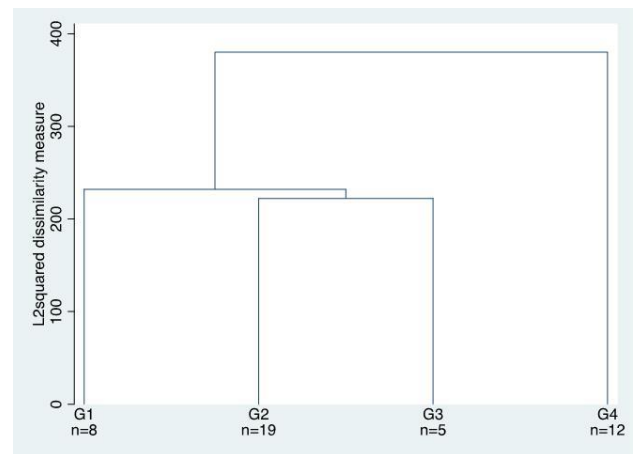*The dendrogram obtained for the top 4 branches of the clustering solution.*

Table 1.
Comparison of two- to six-cluster solutions, adopting Ward's method followed by k-clustering.

k	Point-biserial correlation (PBC)	Silhouette coefficient (SC)	Cluster homogeneity coefficient (HC), when variables are standardized	Explained Error Sum of Squares (EESS) expressed as a percentage
2	.50	.75	1.56	34.92
3	.54	.79	1.18	53.71
4 (8, 19, 5, 12)	.64	.85	0.77	70.76
5	.70	.87	0.39	78.41
6	.70	.91	0.28	86.01

Note. For $k = 4$, we list the n for each group.

Table 2.

Two- to six-cluster solutions, comparing single linkage to complete linkage, each followed by k-clustering

k	Point-biserial correlation (PBC)	Silhouette coefficient (SC)	Cluster homogeneity coefficient (HC), when variables are standardized	Explained Error Sum of Squares (EESS) expressed as a percentage
Single linkage				
2	.41	.67	1.59	28.90
3	.65	.79	1.19	53.75
4	.64	.85	0.77	70.76
5	.70	.87	0.39	78.41
6	.70	.91	0.35	86.01
Complete linkage				
2	.50	.75	1.59	34.92
3	.65	.79	1.19	53.75
4	.64	.85	0.78	70.76
5	.70	.87	0.39	78.41
6	.70	.91	0.28	86.01

Figure 6.

POSAC space in which the various profiles can be mapped, with these appearing along one diagonal.
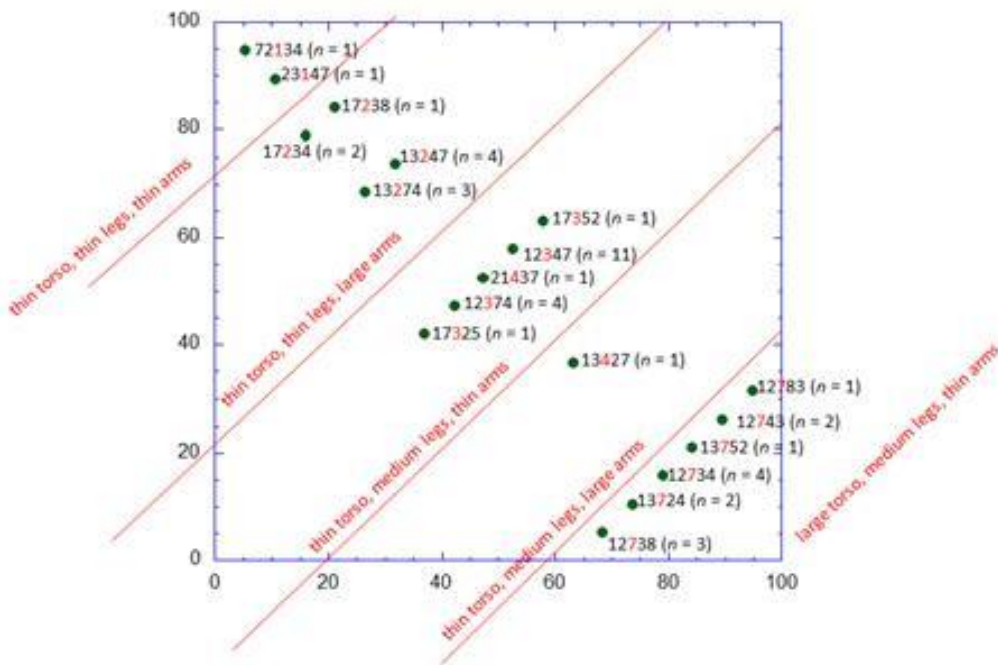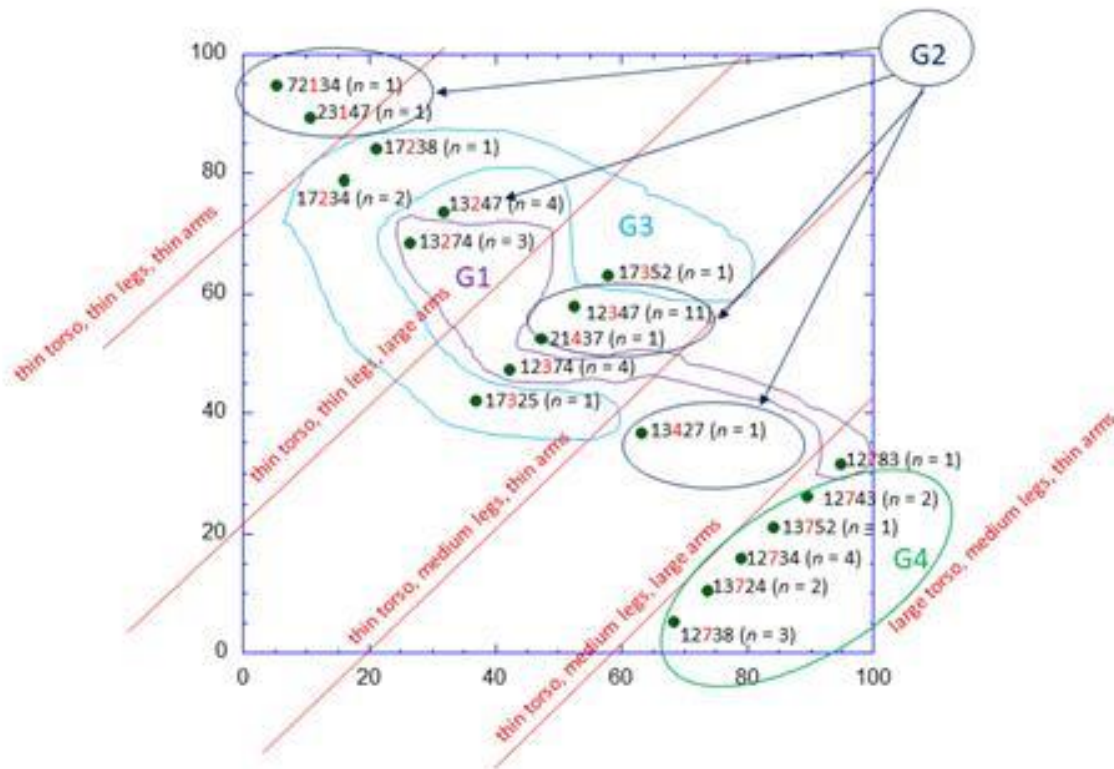
Figure 7.
Superimposition of the four clusters onto the POSAC space.

A second way to analyze the data is to conduct a partial order scalogram analysis by coordinates (POSAC) procedure, as described by Shye (2007). The same set of profiles analyzed above using cluster analysis comprises a scalogram (Shye, 1998, p. 163). Figure 6 is the 2D space in which the various profiles can be mapped, as provided by the POSAC module of Hudap (Shye, 2007). Note the following: (1) the profiles lie on the top-left to bottom-right diagonal, indicating a unidimensional mapping (Merschrod, 1980, p. 636), hence one does not need to consider the 2D coordinates (Dancer, 1990, p. 488); (2) in an attempt to interpret this space, note that a lawful partitioning can be seen when focusing on the listing of images appearing in the third ordinal position; (3) the space can be partitioned using parallel stripes (Shye, 1998, p. 165) perpendicular to this diagonal, and when these are interpreted in terms of the image appearing in the third ordinal position within the profile they indicate the hierarchical structure of the body image; and (4), the participant exhibiting aberrant performance on the task lies at the top left of the diagonal.

Figure 7 presents the superimposition of the four clusters onto this 2D space. Note the following: (1) cluster G4 is clearly marked, and its data points lie perpendicular to the main diagonal; (2) clusters G1, G2 and G3 are not clearly demarked, hence they should be merged into one large cluster, in line with the higher-order clustering appearing in

the dendrogram (Figure 5); and (3), cluster G2 decomposes into three areas, one of which appearing at the top-left of the diagonal, reflects aberrant performance on the task.

Discussion

As Figure 2 clearly shows, ideal body image is on average much thinner than perceived body image, much as has been reported by others (Barnett et al., 2001; Tiggemann, 1992). This discrepancy between perceived and ideal body image reveals the degree of body size dissatifaction (Gardner & Brown, 2010; Swami et al., 2012), and is more apparent with increasing BMI, in line with the findings of others (Thaler et al., 2018; Tovée et al., 2003). Perceived body image, in turn, tends to underestimate actual body image, when viewed in terms of the corresponding BMI-calibrated figure (see Figure 2), and this discrepancy between perceived and actual body image reveals the degree of body size distortion (Gardner & Brown, 2010). This effect is not moderated by group, determined in part by order of presentation (i.e., ascending or descending order) of the PFRS figures, and this lack of effect for particular order of presentation is consistent with the literature (Duncan et al., 2005). Note that body size distortion, as opposed to body size dissatisfaction, can be either one of overestimation or of underestimation of body size (see Figure 2). Participant #11 who exhibits aberrant performance on our rank-

ordering task, and who scores high on the EDI-2 scale of Bulimic Tendencies, has a reported BMI of 29.36, roughly matching the BMI-calibrated image #8. Her perceived body image is veridical (she selected image 9 on the ascending series, and image 8 on the descending series of the PFRS), and this comes in opposition to what has been reported for anorexic women, who tend to overestimate their body size (Gardner & Brown, 2010; Hagman et al., 2015). The ideal body image she indicated was image 4 on both ascending and descending series, which is calibrated with a BMI of 18.45. This is roughly the same ideal body image selected by a bulimic participant in the study reported by Tovée et al. (2003, p. 507). Her body size dissatifaction is thus clearly marked.

Turning to our rank-ordering task, we have an answer to our initial question, and this is that one moves outwards from the center when assessing body shapes. The torso is the first area of attention (Cornelissen et al., 2016; Cundall & Guo, 2017), and if this torso is viewed against the background of the whole body shape, then it should appear larger in size, much as in any figure-ground setting (Glicksohn, 1998; Glicksohn & Berkovich-Ohana, 2011). Participant #11, who chose image #7 of this task (= large torso, medium legs, thin arms) as being the thinnest, is highly deviant in this, given that image #7 is characterized by a large torso. How could such a large torso be justified as being the thinnest body shape for this participant, who is at high risk for bulimia? Tovée et al. (2003) have shown that bulimics tend to overestimate body size and, further, that their ideal body image has a significantly reduced waist and thighs. Clearly, they focus on the torso in making this choice. Given this, our participant should not have designated image #7 as being the thinnest of the series. But, one must take into consideration her own BMI of 29.36, which places her at the upper end of the BMI category of 'overweight' (Tovée et al., 2003, p. 503). Could her choice of thinnest image be codetermined by the images presented and by her own body image? If so, this would suggest that she is highly field dependent, and that remains an issue on our research agenda (Naor-Ziv & Glicksohn, 2016). Body self-schema (Williamson, White, York-Crowe, & Stewart, 2004) might well work in unison with field dependence-independence here (Basseches & Karp, 1984). We can, therefore, set ourselves a future goal of investigating our rank-ordering task with bulimics (or, with those at high risk for bulimia), who should display a distorted body image (Johnsson, 1993), coupled with an assessment of field dependence-independence (Glicksohn & Bozna, 2000; Glicksohn & Kinberg, 2009; Naor-Ziv & Glicksohn, 2016).

What have we learned from employing a person-oriented, data-analytic approach to the data generated by our rank-ordering task? Clearly, the 2D POSAC space neatly portrays these data, and allows us to reveal the hierarchical structure of the body image. The cluster analysis was less successful here, with cluster G2 being seen to relate to separate regions of the 2D POSAC space. Could this be a re-

sult of the appearance of aberrant behavior on the rank-ordering task? Participant #11 chose image #7 as being the thinnest, and this participant is clearly seen at the top-end of the diagonal appearing in POSAC space. Participants #34 and #40 both placed image #2 in first rank order of thinness, and one of these appears next to participant #11 in the POSAC space. In fact, all three of these participants belong to cluster G2. Aldenderfer and Blashfield (1984, p. 61) have recommended that "outliers should be identified before cluster analysis is used, and each should be carefully evaluated to determine the reason it is so different from the other cases." We suggest that rather than removing such outliers at the outset, the juxtaposition of the two analytic procedures employed here enables one to uncover such outliers in a data set. Hence, our prediction for future studies in this domain, employing participants suffering with eating disorders such as bulimia, is that these individuals will be clearly indicated within POSAC space, and will be affiliated in one cluster that does not preserve a contiguous region within that space.

To sum up: We have been able to present the hierarchical structure of the body image, based in part on the high degree of agreement among our participants regarding the rank-ordering of the body shapes presented, and partly on this orderliness of their data, revealed by juxtaposing the results of the two analytical procedures of cluster analysis and POSAC. An anonymous reviewer has questioned whether different results would have been found had real body shapes been rated. Indeed, other types of body shape could be used for our rank-ordering task, and there are a number of these in the literature, such as computer-generated 3D images of a standard model that can be manipulated in line with changing BMI (Cornelissen et al., 2016) and 3D body scans of the actual participant that can be modified to present different BMI versions of the participant (Thaler et al., 2018). This is certainly worthy of research attention of our colleagues who employ these tools.

Of course, the study also has a number of limitations, one of which is the relatively small sample size, though samples of comparable size have previously been reported in the literature when studying the body image (e.g., Thaler et al., 2018) or when employing a rank-ordering task (Böhm & Pfister, 1996). Clearly, it is necessary to replicate the study in order to evaluate the degree of generalizability of the present results—both of the clustering solution and of the partitioning of the 2D POSAC space. Having suggested that the juxtaposition of these two analytical procedures also enabled us to identify an outlier—and one that may well have relevance for the future implementation of both the rank-ordering task and its data analysis in the study of eating disorders—it is important to conduct a similar study in such a population and see whether we can replicate the pattern. That is certainly a goal for our own future work in this domain.

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Author contributions

RK served as the experimenter in this study, which was supervised by RN-Z and JG.

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The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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