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Research article

The role of appearance comparison and body dissatisfaction in influencing passability judgements across body and non-body apertures in VR

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ABSTRACT

Body dissatisfaction, a core feature of body image disturbance (BID), is prevalent among women both with and without eating disorders. Recently, research has demonstrated that individuals with BIDs show alterations in the body schema, a sensorimotor representation essential for movement and action planning. For example, individuals with BIDs overestimate their body size when judging whether they can pass through doorways in an environment. Body dissatisfaction has been closely linked to appearance comparison, particularly in social contexts where other bodies are present. As such, this study investigates whether the presence of other bodies influences body schema distortions in women with high and low body dissatisfaction. Participants (N = 357) were recruited via online questionnaires measuring appearance comparison, motor imagery ability, body dissatisfaction, and interoceptive sensibility. Participants with high (N = 33) and low (N = 31) body dissatisfaction completed a passability judgement task in a virtual reality environment, estimating whether they could pass through apertures formed either by two women (body apertures) or by two poles (non-body apertures). Passability estimates did not differ significantly between groups. However, women with low body dissatisfaction showed greater precision when judging body apertures than non-body apertures. In contrast, women with high body dissatisfaction showed similar precision across both aperture types. Additionally, passability precision was associated with higher levels of appearance comparison and lower interoceptive trust. These findings suggest that body dissatisfaction and appearance comparison may influence the precision with which women mentally represent and estimate the space their bodies occupy.

1. Introduction

Body dissatisfaction is characterised by negative subjective evaluations about one's weight and shape and is considered the attitudinal expression of body image disturbance (BID) [1]. BID typically emerges at a perceptual and/or attitudinal level and is considered both a risk factor and a core symptom of eating disorders (EDs) [2]. Many studies highlight that attitudinal BID, presenting as body dissatisfaction is 'normative' in women in the general population [3]. As such, research increasingly recognises the importance

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of investigating BID within the general population [3]. Studies have revealed significant similarities between individuals with high body dissatisfaction and those with EDs, including excessive dieting [4], compulsive exercise [5], diminished awareness of internal states (for review see Ref. [6]), and oversized perceptions of body size and shape [7]. Recently, studies have shown that individuals with EDs not only perceive their bodies as larger than veridical but also navigate environments as if their bodies occupy more space than their true physical dimensions [8]. An important question that persists is whether this altered body representation is an exclusive clinical characteristic of EDs or if it also reflects BIDs experienced by women in the general population.

Our ability to interact seamlessly with the external world stems from our innate capacity to perceive opportunities for action and execute the appropriate motor responses without conscious awareness of our bodies [9]. This unconscious body representation is called the body schema: an automatic system of sensorimotor processes for action and action planning (i.e. motor imagery) [10]. The body schema is a supramodal representation that continuously integrates information from various sensory modalities, including exteroception (awareness of external stimuli), interoception (awareness of the body's internal state), and proprioception (awareness of body position and movement) to maintain a dynamic representation of the body during action [10]. Thus, our body schema serves as a primary reference for visuospatial perception by converting spatial information to anthropometric dimensions (body-scaling) to determine possibilities for action [9].

Recent evidence suggests that disturbances in body image are linked to disruptions in body schema. Individuals with BIDs, such as Anorexia Nervosa and Bulimia Nervosa, not only hold distorted perceptions and attitudes towards their body size but also exhibit systematic alterations in their body schema [8]. A common task used to assess the body schema in individuals with BIDs is the aperture task, where participants judge their ability to pass through gaps (e.g. doorways) of varying sizes. Individuals with anorexia nervosa have been consistently observed to overestimate their shoulder widths (up to 40% wider than their measured shoulder widths), both when assessing actual [11] and imagined [12] passability through apertures. Additionally, recent research suggests that after embodying larger avatars, individuals with anorexia nervosa overestimate spatial dimensions to a greater extent than when embodying underweight avatars in the aperture task, indicating a less stable body schema and greater bodily self-plasticity compared to controls [13]. Interestingly, Guardia et al. [14] discovered that passability estimates were related to participants' levels of body dissatisfaction, suggesting that this phenomenon might be indicative of attitudinal BID rather than a specific clinical feature of EDs.

A potential explanation for this comes from the Allocentric Lock Hypothesis (ALH) [15]. The ALH proposes that BID may influence egocentric processing by redirecting attention toward the external appearance at the expense of internal signals (i.e. interoception). Since receiving dynamic and multimodal sensory information is crucial for developing the body schema, this dominance of exteroceptive information could lead to an inaccurate third person (allocentric) representation of the body in memory [15]. Indeed, research suggests that in the absence of accurate interoceptive information, the representation of the body is primarily exteroceptive [15]. There is now mounting evidence that individuals with EDs are focused on their external body [16] and consistently report lower awareness of and attention towards, their internal states across all domains of interoception (See: Martin [17] for review). In line with this, research indicates that individuals with EDs are more susceptible to experiencing body ownership of a rubber hand during the rubber hand illusion [18]. This phenomenon is often attributed to excessive reliance on exteroceptive information, such as vision, at the expense of interoceptive cues [19]. Additionally, in individuals without EDs, BIDs are associated with reduced subjective perception of bodily states (i.e. interoceptive sensibility) [6], suggesting that aspects of the ALH can be applied to some extent to the general population.

Whilst our previous work has shown that women in the general population with higher BIDs may exhibit an altered body schema through slower performance in an online motor imagery task [20]. Further research is needed to assess the links between BID and the body schema using more ecologically valid measures of body schema, such as aperture tasks. Research examining whether BIDs are associated with altered body schema in non-clinical populations remains limited, with inconsistent findings from aperture tasks. For example, in the standard aperture task, Glashouwer et al. [21] found no significant differences in aperture passability between women with high and low body image concerns. Additionally, Wignall et al. [22] found that only eating restraint scores, not body image scores, predicted wider passability estimates in healthy women. This suggests that disordered eating behaviour may be more closely associated with altered body-scaling than with BID. Alternatively, a study by Irvine et al. [23] found that passability estimates were significantly influenced by body image, especially in women with high levels of body dissatisfaction. Similarly, Boucher et al. [24] used a tactile distance estimation task and found that women with higher body dissatisfaction tended to overestimate distances between tactile stimuli, particularly on the abdomen and thighs. Other studies suggest that women with high body dissatisfaction show lower self-reported vividness of the mental representation of the body in body schema tasks, as opposed to actual altered task performance [8]. Taken together, there is currently mixed evidence that BID in women without EDs is linked to an altered body schema using the aperture task.

Most studies examining aperture passability in individuals with BID use non-human physical objects, such as doorways. However, both body image and body schema are context-dependent [25], and distortions in both may not consistently manifest in response to the same type of stimulus (e.g., a doorway). For example, social comparison theory [26] suggests that social interactions can intensify body dissatisfaction in women by promoting appearance-based comparisons. Upward comparisons with those perceived as more attractive often result in negative emotions, while downward comparisons with those seen as less attractive tend to elicit positive emotions [27]. Indeed, studies consistently show that women with high levels of body dissatisfaction frequently compare their faces and bodies with those of other women [27].

Furthermore, eye-tracking studies consistently reveal that women with high levels of body dissatisfaction spend significantly more time fixating on images of idealised thin women compared to those with lower levels of dissatisfaction [28]. Therefore, the presence and exposure to other bodies are more likely to induce appearance comparison in individuals with high body dissatisfaction and may influence body-related judgements. For example, a recent study in Virtual Reality (VR) found that viewing a central body surrounded

by a crowd of larger or smaller bodies led to a misestimation of the size of the central body, with greater misestimations in healthy women with ED traits [29]. However, it is currently unclear whether viewing and interacting with other bodies in an environment influences one's perception of one's body schema.

The body schema is not only engaged in estimating the dimensions of one's own body in space but also becomes activated when observing another human body [30]. This shared representation is crucial for establishing one's peri-personal space - a safety buffer around the body, including objects and individuals within reach [31]. The body schema unconsciously encodes body positions for both oneself and others [30], and is distinct from neural networks involved in object recognition [30]. Observing other bodies activates the body schema through a process of *self-other matching* [32]. Evidence for this comes from the body-part compatibility task [33], where participants view images of human bodies with coloured dots on various limbs and respond with corresponding limb actions (e.g., hand actions for red dots, foot actions for blue dots), irrespective of dot location. In this task, responses are typically faster when the dot colour matches the limb action. This suggests that observing a body part activates and reinforces the viewer's body schema, enhancing motor response efficiency and integrating observed body parts into one's own action framework [33].

Extensive research supports the idea of shared or overlapping body representations between oneself and others [32]. For example, Hackney et al. [34] examined how individuals navigate apertures formed by non-human objects (two poles) versus humans (two female confederates). They found that participants had higher passability estimates when viewing humans, suggesting that they accounted for the dimensions and peri-personal space of the other humans in their body schema judgements. Interestingly, recent work by Aniulis et al. [25] used a modified aperture task in which healthy women were presented with apertures formed by either two larger-bodied or two smaller-bodied silhouettes of women projected on a wall, and were asked to decide whether they could pass through them. The results showed that larger passability estimates correlated with body dissatisfaction in the smaller-bodied condition but not in the larger one. This indicates that body-based apertures may be more relevant in observing the links between body image and body schema in individuals without EDs.

However, the study by Aniulis et al. [25] and others mentioned earlier [14] used static 2D stimuli projected on a wall to assess aperture passability. This approach reduces the natural 3D volume of the body/doorway to a 2D surface, removing essential volumetric cues that aid in perceptual judgments [35]. Indeed, incorporating 3D cues enhances the accuracy of representations processed by the brain's body-processing regions [30]. VR allows for immersive 3D viewing of environments, and studies consistently support its use for evaluating and treating BID [36]. Therefore, the present study investigates the relationship between attitudinal BID (which is prevalent among women in the general population) and the body schema. Given that aperture task research on BIDs are validated to assess body schema distortions in women as discussed in depth above, the present study will recruit women only. Men's body image concerns may be more strongly shaped by muscularity ideals, which could influence aperture passability judgements differently and as such future research should investigate men independently. This study will examine how body dissatisfaction and appearance comparison influence passability judgments through body and non-body apertures, to advance understanding of how attitudinal BID relates to the representation of the body in action. Additionally, we assess whether body dissatisfaction is related to the vividness of motor imagery to determine whether BID influences the subjective experience of the body schema. Finally, to explore whether passability judgments and BID are associated with appearance comparison and interoceptive sensibility (as a proxy for egocentric processing, as proposed by the ALH) we also include measures of these constructs.

In line with the research, we hypothesise the following.

- A. There will be a main effect of body dissatisfaction group on aperture passability ratios: Women with high body dissatisfaction will have larger overall passability ratios than women with low body dissatisfaction (across human and non-human apertures).
- B. There will be a main effect of aperture type on passability ratio, such that there will be significantly higher passability ratios in human compared to non-human apertures types.
- C. There will be a significant interaction effect between body dissatisfaction group and aperture type
- D. Women in the high body dissatisfaction group will have higher passability ratios for both types of aperture than those in the low body dissatisfaction group.
- E. Women with high body dissatisfaction will report lower vividness of mental imagery across external, internal and kinaesthetic mental imagery compared to women with low body dissatisfaction.

2. Materials and methods

This was a cross-sectional, pre-registered (<https://doi.org/10.17605/OSF.IO/T4WB5>) study conducted online (Part A) and in person (Part B). In Part A, we collected questionnaire data online on self-reported body image, interoceptive sensibility, and motor imagery vividness. Then, based on participants' responses to a measure of trait body dissatisfaction, a subset of the initial sample was allocated to a high or low body dissatisfaction group and completed Part B (an experimental VR task). These two phases are described in detail in the subsequent sections.

2.1. Participants

Participants in this study were recruited in two parts. Part A was conducted online between 29 September 2023 and 4 September 2024 with women resident in the Republic of Ireland. Part B was conducted in person during the same study period at the School of Psychology laboratory, University College Dublin, Ireland. Recruitment to Part B occurred on a rolling basis, with Part A responses reviewed weekly to identify participants who met eligibility criteria for invitation to the VR lab component. Participants for Part A

were recruited through convenience sampling using SONA, mailing lists, and social media advertisements. The study was advertised as an online survey on body image, motor imagery, and related psychological factors. At the end of the survey, participants could opt in to be contacted about a VR follow-up study. They were not informed that VR eligibility was based on body dissatisfaction scores, to reduce demand characteristics.

The inclusion/exclusion criteria for this study is as follows: For Part A, participants were eligible if they identified as women, were aged 18–50 years, were able to read and write in English, and were living on the island of Ireland. For Part B, participants were required to meet the Part A eligibility criteria, be living in or able to travel to Dublin for in-person testing at University College Dublin, and have normal or corrected-to-normal visual acuity in both eyes. Participants also had to meet criteria for either the high or low body dissatisfaction group based on their BSQ-8 scores. Participants were excluded from Part B if they self-reported a current eating disorder, scored above the specified SCOFF screening threshold, reported extreme motion sickness, reported any medical, neurological, mobility, or movement-related condition that could prevent safe participation in VR or interfere with the aperture task, or had very low visual imagery scores consistent with visual hypophantasia or aphantasia. This final criterion was applied because the aperture task required participants to be able to imagine their bodies to perform the task.

In Part A, 357 women ($M = 25.48$, $SD = 7.55$, $Range = 18 - 49$) completed the survey. Participants were grouped into high ($N = 93$) and low ($N = 92$) body dissatisfaction groups and invited to Part B of the study. Sixty-four participants took part in the Part B lab study, with 33 in the high body dissatisfaction group and 31 in the low body dissatisfaction group (See [Supplementary Table 1](#) for demographic information). Participants were given a €12 shopping voucher on completion of the study. The study was approved by the Human Research Ethics Committee at University College Dublin in line with the Declaration of Helsinki. Additionally, all participants gave informed consent to take part. For Part A, we calculated a minimum sample size of 190 women to adequately account for skewness in both directions. This calculation is based on Piovesana et al. [37], who found that sample sizes exceeding 85 participants produce stable means and standard deviations, regardless of the degree of skewness in a single direction. To determine the appropriate sample size for the Part B lab experiment, we conducted an a-priori power analysis using GPower 3.1.9.2, as pre-registered. To detect an effect size of partial eta squared = 0.14 (large effect) with 95% power in repeated measures, between-subjects ANOVA (2 groups, $\alpha = 0.05$, non-sphericity correction = 1), GPower indicated a required total of 64 participants. Previous studies using the aperture task in a within-subjects design typically recruit 30 subjects per group [14].

2.2. Questionnaires

2.2.1. Body dissatisfaction

Body dissatisfaction was measured using the 8-item version of the Body Shape Questionnaire, which measures the degree of concern over one's body shape (BSQ-8) [38]. The BSQ-8 has validated cut-off scores for determining levels of body dissatisfaction: scores less than 19 indicate no concern with body shape, scores between 19 and 25 reflect mild concern with body shape, scores from 26 to 33 signify moderate to high concern with body shape, and scores over 33 denote marked concern with body shape. To ensure significant differences in body dissatisfaction between the two groups, participants who scored greater than 30 were placed in the high body dissatisfaction group, while those who scored less than 20 were placed in the low body dissatisfaction group. The highest possible score on the BSQ-8 is 48. The BSQ-8 demonstrates high test-retest reliability, convergent validity and internal consistency [39]. Cronbach's α for the BSQ-8 was 0.94 in our study sample.

2.2.2. Physical appearance comparison

Physical appearance comparison was assessed using the Physical Appearance Comparison Scale-Revised (PACS-R) [40].

The PACS-R is an 11-item questionnaire designed to measure the tendency to compare one's physical appearance to others across various social settings. Responses are rated on a 5-point Likert scale, ranging from 'Never' to 'Always.' Higher scores indicate greater levels of appearance comparison, with scores ranging from 0 to 4. Cronbach's α for the PACS-R was 0.96 in our study sample.

2.2.3. Interoceptive sensibility

Interoceptive sensibility was assessed using the Multidimensional Assessment of Interoceptive Awareness (MAIA-2) [41]. This questionnaire includes 8 subscales that measure Noticing, Not-Distracting, Not-Worrying, Attention Regulation, Emotional Awareness, Self-Regulation, Body Listening, and Trusting. We omitted the Not-Distracting scale due to its low importance within the context of body image as demonstrated by previous studies [20]. Responses on each subscale were summed and divided by the number of questions to create a score. Cronbach's α scores for the subscales in this study were as follows: Noticing (0.68), Not Worrying (0.25), Attention Regulation (0.86), Emotional Awareness (0.81), Self-regulation (0.81), Listening (0.83), and Trusting (0.89).

2.2.4. Motor imagery vividness

Motor imagery vividness was assessed using the Vividness of Movement Imagery Questionnaire 2 (VMIQ-2) [42], which tests for individual differences in the vividness of mental imagery. This questionnaire evaluates twelve movements (e.g., running, cycling, throwing a stone in water) across three imagery modes: external visual imagery (EVI) "Watching yourself performing the movement", internal visual imagery (IVI) "Looking through your own eyes whilst performing the movement", and kinaesthetic imagery (KIN) "Feeling yourself do the movement". Participants imagined these movements with closed eyes without physically performing them and rated the vividness of each image on a 5-point Likert scale (1 = Perfectly clear and vivid, 5 = No image at all). The totals for each subscale (EVI, IVI, and KIN) were individually calculated by summing the scores for each item. Higher scores indicate lower imagery vividness. Cronbach's α were calculated for the EVI (0.95), IVI (0.95) and KIN (0.96) subscales, respectively.

2.2.5. The SCOFF questionnaire

The SCOFF (Sick, Control, One, Fat, Food) is a 5-item yes/no screening tool for detecting EDs [43]. It asks participants if, in the past year, they 1) lost more than one stone in 3 months (6.3 kg), 2) made themselves sick due to feeling uncomfortably full, 3) worried about losing control/overeating, 4) believed they were fat despite being told they were too thin, and 5) felt that food dominated their life. Endorsement of ≥ 2 items suggests a possible ED. Considering we were recruiting a high body dissatisfaction sample, we placed the cut-off at >2 to account for the body image question (4). The SCOFF has demonstrated good reliability and validity [43].

2.2.6. Aperture task

2.2.6.1. Stimuli. The aperture task stimuli involved two types of apertures: non-body and body. The non-body apertures were represented by two white columns created using Unity elements (Fig. 1A), while the body apertures consisted of two female avatars in a neutral standing position facing the participants (Fig. 1B). The avatars were sourced from www.mixamo.com. Stimuli were based on those from Hackney et al. [34].

Both the non-body and body apertures at default were standardised in height (173.6 cm) and width (44 cm) at baseline. Considering the different geometrical shapes of the aperture in the body and non-body apertures, the aperture heights (both non-body and body) were scaled to match the participant's height (e.g., if a participant was 178 cm tall, the columns and avatars were also set to 178 cm). This ensured that participants were presented with eye-level stimuli and could estimate aperture passability based on eye height information. This aligns with research indicating that individuals rely on eye height information (the top half of the aperture) to determine if they can pass through an aperture [44]. The width of the apertures were scaled proportionally with height (100 cm height = 25.35 cm width) to prevent distortion and maintain realistic proportions, particularly for the human avatars. Apertures were positioned at a virtual distance of 5.50 m from the participants' standing position in the real world. This distance was selected to ensure that the aperture appeared as a realistic, door-like opening visible from floor to top, replicating the setup used in previous studies employing the aperture task in individuals with BIDs [14].

Aperture distances for the non-body stimuli were measured from the inner edges of both columns. For the body stimuli, the apertures were measured between the inner edges of each avatar's shoulders, consistent with previous research using similar variations of the aperture task (comparing humans to columns) (e.g., Hackney et al. [34]).¹ The task was presented in a VR park setting to create an ecologically valid setting (See Fig. 1). The technical implementation of the task was carried out using the Unity game engine, version 2019.4.15f1 LTS [45]. VR equipment used were the Oculus Quest 2 headset and Touch hand controllers.

In random order, participants were presented with 51 aperture distances ranging from 30 cm to 80 cm in 1 cm increments. Each aperture distance was presented four times for both aperture types (204 x body, 204 x non-body), resulting in 408 trials. The trials were organized into a counterbalanced block design, divided into four blocks of 102 trials each. Each block contained one aperture type (body/non-body), with each aperture distance presented twice per block, and the block order was counterbalanced across participants.

3. Procedure

3.1. Part A

Participants completed the online survey questionnaires (BSQ, PACS-R, MAIA-2, SCOFF, VMIQ-2). Demographic data included participants' age, ethnicity, presence of existing mental health condition/s and whether they had/have an ED. At the end of the survey, participants were asked if they would like to participate in a VR study in the lab. To prevent feelings of negative body image from influencing their decisions, participants were blinded to the true nature of the study, similar to other studies employing the aperture task to assess body image (see: Keizer et al., [11]). As such, the experiment was presented to participants as investigating spatial navigation in different contexts in VR.

3.2. Part B

When participants entered the lab, they were introduced to the study and their height and handedness were recorded. The height measurement was entered into the aperture task software to resize avatars according to each participant's height. Participants were then fitted with an Oculus Quest 2 VR headset and introduced to the VR environment. Before starting the task, participants were given practice trials where they were shown either red or green cubes and asked to respond with 'Yes' for green cubes and 'No' for red cubes. This practice was designed to familiarise participants with using the controllers to make 'yes' and 'no' judgements. The practice session was stopped once participants reached 30 correct responses consecutively. After completing the practice task, participants were given the actual task where they were instructed to imagine walking through an aperture formed by columns or humans without rotating

¹ To address that other body part distances of the avatars are wider than the shoulders, and to compare these with the column apertures, a sensitivity analysis was conducted (See supplementary analysis 1). This analysis compared the passability responses for the distances at each participant's critical aperture in the column condition with the distances between different body part distances on the avatars to investigate whether these distances were comparable to the column apertures. The analysis demonstrated no significant differences in passability judgement between body and non-body aperture for the upper half of the apertures across any distances apart from the shoulder (which was the comparison point). This indicates that participants were likely using the distance between the avatars shoulders to make passability judgements.

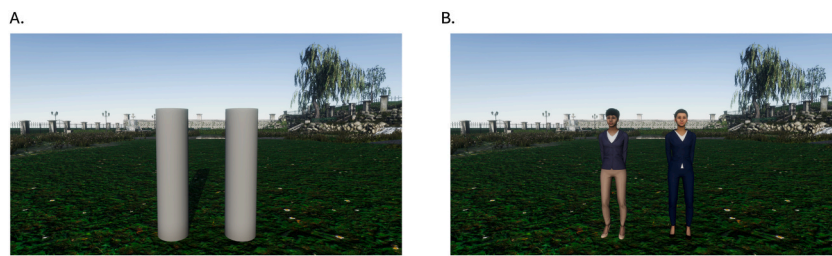


Fig. 1. Example of the (A) non-body and (B) body stimuli used in the aperture task (aperture distance = 50 cm). Both body and non-body apertures were standardised in height (173.6 cm) and width (44 cm) at baseline, with aperture height subsequently scaled to each participant's height (e.g., a 178 cm participant viewed 178 cm avatars/columns).

their shoulders. They were asked to judge whether they could fit through the space created by the apertures and to respond by pressing a button on the Oculus hand controllers: 'Yes' with their dominant hand or 'No' with their non-dominant hand. Their handedness configuration was pre-programmed into the program prior to the commencement of the practice session. Once participants completed the experiment, their shoulder width was measured using a tape measure and they were asked to disclose their weight (optional). Participants were then debriefed and informed that the study aimed to investigate the relationship between their body image responses (from the survey) and their performance in the aperture task.

4. Data analysis

4.1. Questionnaire data

The descriptive statistics for the full sample ($N = 357$) and the high and low body dissatisfaction grouped samples are presented in the subsequent sections. Considering that the Not-Worrying MAIA-2 sub-scale had the lowest internal consistency it was excluded from the analysis. Statistical analyses were conducted using R Statistics [46] and JASP (Team, JASP, 2023). Effect sizes, (Cohens 'd for t-tests and partial eta squared for ANOVA's) were used to estimate the main effects and between-group differences. Greenhouse–Geisser corrections were used when Mauchly's test for sphericity was significant and Bonferroni corrections for multiple comparisons were applied to post hoc tests where appropriate.

4.2. Aperture task data

The aperture task measured the body schema in two dimensions: the Passability Ratio and the Just-Noticeable Difference.

a) The Passability Ratio

The passability ratio for participants was calculated for both the body and non-body conditions based on Guardia et al. [12]. We first determined the perceptual threshold corresponding to the perceived *critical aperture*, which is the aperture size that resulted in a 50% positive response rate (See Fig. 2 for an example). The perceived critical aperture was calculated using the formula:

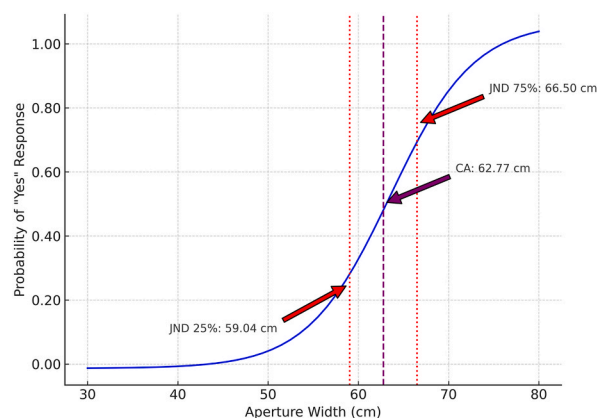


Fig. 2. Psychometric functions for one participant (In the high body dissatisfaction group, for the Column Aperture). The critical aperture (CA) corresponds to the 50% positive "Yes" response rate (54.25 cm). The just noticeable difference (JND) value is represented by the difference in aperture widths at 25% and 75% positive "Yes" response rates (Y axis) divided by 2 (i.e. 3.73).

$$\text{Answer} = 1 / [1 + \exp(-k(c - \text{aperture}))]$$

Where 'c' represents the perceived critical aperture (in cm) with a 50% positive response rate, and 'k' is the slope of the curve around the point 'c'. The steepness or shallowness of the slope serves as an indicator of discriminability, with steep slopes signifying strong discrimination ability and shallow slopes indicating weaker discrimination ability [12].

Then, we divided the perceptual threshold by the participants' shoulder width to calculate the perceived passability ratio for both the body and non-body aperture conditions. The passability ratio indicates a person's estimate of their body size in relation to the width of their shoulders. If the passability ratio is equal to 1, the perceptual threshold is equal to the width of the participant's shoulders. The larger the passability ratio, the greater the width that the person estimates they need to pass through the aperture [12].

b) Just Noticeable Difference

We also calculated the *Just Noticeable Difference (JND)*, a standard psychophysical measure in perceptual tasks, to provide a measure of the precision of participants over/underestimation. Precision is considered high when the JND is low, meaning participants are likely more confident/certain when judging passable versus non-passable apertures.

The JND was calculated by subtracting the aperture value corresponding to a 75% 'yes' response rate from the value at the 25% response rate and then dividing the result by two. This midpoint represents the smallest difference a participant could discern between an aperture and their own perceived body size (see Fig. 2 for an example).

5. Results

5.1. Part A: questionnaire results

5.1.1. Descriptives

The means and standard deviations for all variables collected in the questionnaire are presented in Table 1.

5.1.2. The relationships between negative body image, interoceptive sensibility and self-reported vividness of motor imagery

Pearson's r correlations were conducted for all variables. See Fig. 3 for the statistics and full reported correlations between all variables.

5.1.3. The relationship between negative body image and interoceptive sensibility

As shown in Fig. 3. Body dissatisfaction (BSQ scores) were significantly negatively correlated with several subscales of the MAIA-2. Specifically, significant negative correlations were found between the BSQ and the Trusting ($p < .001$), Listening ($p < .001$), Self-Regulation ($p = .006$), Emotional Awareness ($p = .013$), and Attention Regulation ($p = .016$) subscales. However, there was no significant correlation between body dissatisfaction and the Noticing subscale ($p = .176$).

Regarding the relationships between appearance comparison and MAIA-2 scores, significant negative correlations were observed between appearance comparison and the Trusting ($p < .001$), Listening ($p = .020$), Self-Regulation ($p = .006$), and Attention Regulation ($p = .016$) subscales of the MAIA-2. In contrast, there were no significant correlations between appearance comparison and the Emotional Awareness ($p = .121$) and Noticing ($p = .528$) subscales.

5.1.4. The relationships between body image and motor imagery vividness

As shown in Fig. 3. The correlation analysis indicated that body dissatisfaction scores were significantly positively correlated with the EVI ($p = .009$) and IVI ($p = .009$) subscales of the VMIQ-2 (Motor Imagery Vividness Questionnaire). However, there were no significant correlations between body dissatisfaction and the KIN subscale ($p = .069$).

Regarding the relationships between appearance comparison and VMIQ-2 scores, significant positive correlations were observed

Table 1

Table 1. Means, standard deviations, and 95% confidence intervals for questionnaire responses from participants in the Part A survey (N = 357).

Questionnaire	Means	Standard Deviation	95% CI ^a
Body Shape Questionnaire (BSQ)	27.98	10.75	26.87 – 29.11
Appearance Comparison (PACS-R)	36.38	11.37	35.21 – 37.57
VMIQ2 - EVI	29.24	12.51	27.94 – 30.55
VMIQ2 - IVI	23.24	11.08	22.09 – 24.40
VMIQ2 - KIN	24.71	12.48	23.42 – 26.01
MAIA – NOTICING	3.15	0.98	3.04 – 3.24
MAIA – ATTENTION REGULATION	2.40	0.97	2.30 – 2.50
MAIA – EMOTIONAL AWARENESS	3.20	1.08	3.09 – 3.31
MAIA – SELF-REGULATION	2.23	1.07	2.12 – 2.34
MAIA - LISTENING	2.09	1.19	1.97 – 2.22
MAIA - TRUSTING	2.40	1.39	2.25 – 2.54
SCOFF	1.26	1.19	1.14 – 1.39

^a 95% CI = 95% Confidence Interval.

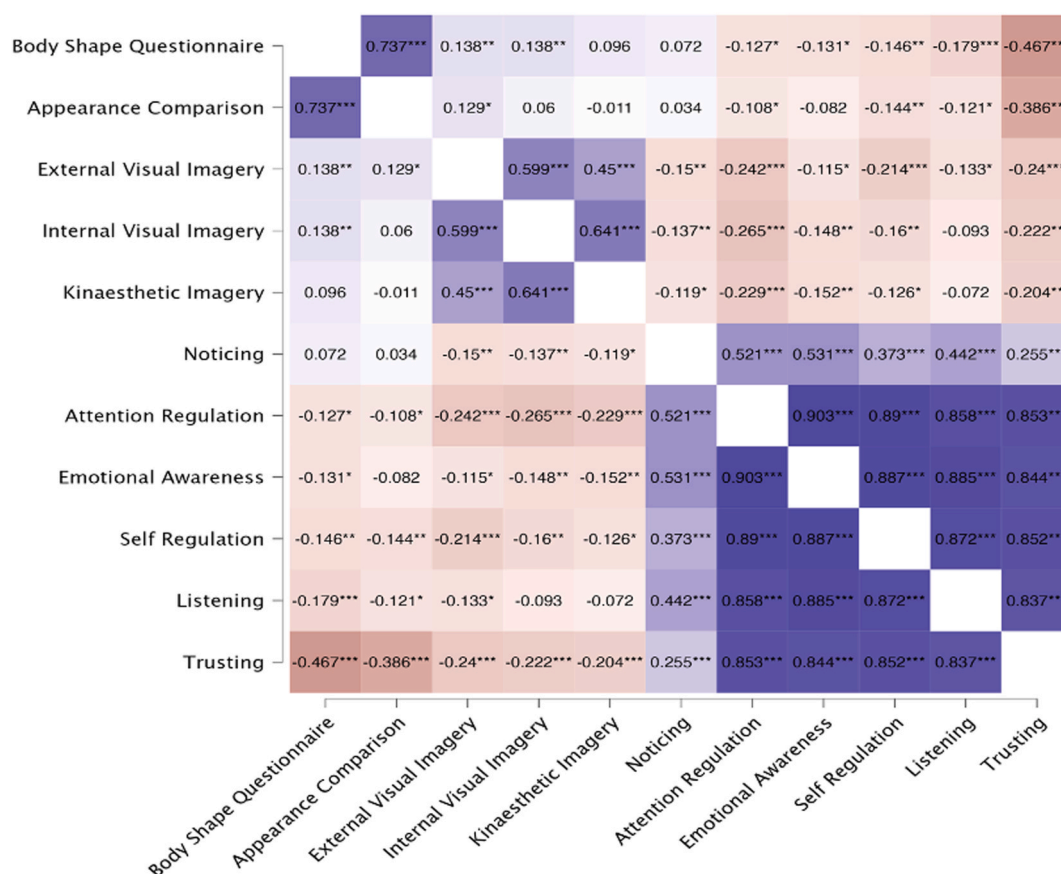


Fig. 3. Correlation matrix of all variables collected in the study. Values represent Pearson correlation coefficients (r). Statistical significance as follows: * $p < .05$, ** $p < .01$, *** $p < .001$. Purple boxes depict positive correlations, orange boxes depict negative correlations.

between appearance comparison and the EVI ($p = .015$). In contrast, there were no significant correlations between appearance comparison and the IVI ($p = .255$) and KIN ($p = .834$).

5.1.5. The relationships between motor imagery vividness and interoceptive sensibility

As shown in Fig. 3, the correlation results indicate that external visual imagery was significantly negatively correlated with the Noticing ($p = .005$), Attention Regulation ($p = .001$), Emotional Awareness ($p = .029$), Self-Regulation ($p < .001$), Listening ($p = .012$), and Trusting ($p < .001$) subscales of the MAIA-2.

Additionally significant negative correlations were found between internal visual imagery and the Noticing ($p = .010$), Attention Regulation ($p < .001$), Emotional Awareness ($p = .005$), Self-Regulation ($p = .002$), and Trusting ($p < .001$) subscales of the MAIA-2.

Table 2

Means and standard deviations for questionnaire responses among participants who took part in the Part B lab experiment, and ANOVA results comparing responses between the high and low body dissatisfaction groups.

Variables	High (N = 33)	Low (N = 31)	ANOVA
BSQ	37.030 (6.569)	14.548 (2.908)	$F(1,62) = 306.43, p < .001, \eta_p^2 = .832^*$
PACS-R	39.515 (9.162)	23.161 (6.719)	$F(1,62) = 65.60, p < .001, \eta_p^2 = .514^*$
VMIQ2 - EVI	30.273 (13.034)	28.032 (11.557)	$F(1,62) = 0.53, p = .471, \eta_p^2 = .008$
VMIQ2 - IVI	24.606 (10.715)	21.806 (9.375)	$F(1,62) = 1.23, p = .272, \eta_p^2 = 0.0019$
VMIQ2 - KIN	25.879 (11.667)	24.645 (11.904)	$F(1,62) = 0.18, p = .677, \eta_p^2 = .003$
MAIA - NOTICING	2.89 (1.09)	3.08 (1.11)	$F(1,62) = 0.50, p = .482, \eta_p^2 = .008$
MAIA - ATTENTION REGULATION	2.42 (1.03)	2.66 (0.90)	$F(1,62) = 0.98, p = .325, \eta_p^2 = .016$
MAIA - EMOTIONAL AWARENESS	2.92 (1.18)	3.46 (1.02)	$F(1,62) = 3.78, p = .056, \eta_p^2 = .057$
MAIA - SELF-REGULATION	2.14 (1.17)	2.53 (1.19)	$F(1,62) = 1.73, p = .194, \eta_p^2 = .027$
MAIA - LISTENING	1.76 (1.23)	2.40 (1.26)	$F(1,62) = 4.24, p = .044, \eta_p^2 = .064^*$
MAIA - TRUSTING	2.20 (1.37)	3.50 (1.23)	$F(1,62) = 15.76, p < .001, \eta_p^2 = .203^*$

Note. *Statistically significant difference between groups.

However, there were no significant relationships between the IVI subscale and the Listening subscale ($p = .079$) of the MAIA-2.

Significant negative correlations were observed between Kinaesthetic imagery and the Noticing ($p = .024$), Attention Regulation ($p < .001$), Emotional Awareness ($p = .004$), Self-Regulation ($p = .017$), and Trusting ($p < .001$) subscales of the MAIA-2. There were no significant relationships between the KIN subscale and the Listening subscale ($p = .176$) of the MAIA-2.

5.2. Part B: Lab experiment

5.2.1. Body dissatisfaction grouped sample characteristics

Table 2 shows the means, standard deviations, and results from the ANOVA analyses comparing participants in the high and low body dissatisfaction groups that participated in the Part B lab study. Descriptive statistics and ANOVA results for participants that were categorized into high and low body dissatisfaction groups in Part A, who did not participate in the lab study, are presented in Supplementary Table 2.

5.2.2. Morphological parameters

Significant differences in morphological parameters were observed between the high and low body dissatisfaction groups (see Table 3 for means, standard deviations, and ANOVA results). Specifically, individuals in the high body dissatisfaction group had wider shoulders, weighed more, and had higher BMIs than the low body dissatisfaction groups (see Table 3 for means and SDs). No significant differences in height were observed between the groups.

5.2.3. Comparing judgements of passability for human vs. non-human apertures in women with high and low body dissatisfaction

Table 3 reports the critical aperture, slope, and passability ratios as a function of participant group and aperture condition.

5.2.4. Passability Ratio

To explore differences in the passability ratio between the two aperture types and body dissatisfaction levels, a 2 (Aperture Type: Body, Non-Body) $\times$ 2 (Group: High Body Dissatisfaction, Low Body Dissatisfaction) repeated measures ANOVA was conducted. The analysis revealed a significant main effect of aperture ($F(1,62) = 130.97, p < .001, \eta_p^2 = .679$). Post-hoc comparisons indicate higher passability ratios in the non-body condition ($M = 1.35, SD = 0.27$) compared to the body condition ($M = 1.13, SD = 0.26$) ($t = -11.444, SE = 0.019, p < .001$). However, there was no significant interaction between aperture type and group ($F(1, 62) = 1.51, p = .224, \eta_p^2 = .024$). See Fig. 4 for a visualisation of the ANOVA result.

6. Just noticeable difference (JND)

The same ANOVA was performed to investigate the JND. The results showed a main effect of aperture type ($F(1,62) = 7.63, p = .008, \eta_p^2 = 0.110$). Post-hoc comparisons indicate higher JNDs in the non-body condition ($M = 4.54, SD = 1.83$) compared to the body condition ($M = 3.92, SD = 2.05$) ($t = -2.762, SE = 0.229, p = .008$). Additionally, there was a significant interaction between aperture

Table 3

Descriptive statistics and ANOVA results comparing the high and low body dissatisfaction groups on psychometric, psychophysical, and morphological measures across conditions in the Part B VR lab experiment.

	High Dissatisfaction (N = 33)	Low Dissatisfaction (N = 31)	ANOVA Results
	Mean (SD)	Mean (SD)	
Body Aperture			
Critical Aperture	48.27 (8.04)	43.75 (8.62)	$F(1, 62) = 4.72, p = .034, \eta_p^2 = .071^*$
Slope (K)	0.148 (0.059)	0.199 (0.118)	$F(1, 62) = 4.93, p = .030, \eta_p^2 = .074^*$
Passability Ratio	1.153 (0.23)	1.103 (0.29)	$F(1, 62) = 0.57, p = .453, \eta_p^2 = .009$
JND	4.40 (1.98)	3.41 (2.03)	$F(1, 62) = 3.86, p = .05, \eta_p^2 = .059^*$
Non-Body Aperture			
Critical Aperture	56.46 (9.18)	53.15 (7.91)	$F(1, 62) = 2.36, p = .130, \eta_p^2 = .037$
Slope (K)	0.138 (0.05)	0.147 (0.06)	$F(1, 62) = 0.316, p = .576, \eta_p^2 = .005$
Passability Ratio	1.347 (0.26)	1.344 (0.26)	$F(1, 62) = 0.002, p = .963, \eta_p^2 = .000$
JND	4.47 (1.45)	4.60 (2.197)	$F(1, 62) = 0.074, p = .786, \eta_p^2 = .001$
Morphological measurements			
Height (CM)	167.87 (8.76)	168.83 (7.20)	$F(1, 62) = 0.227, p = .635, \eta_p^2 = .004$
Shoulder Width (CM)	42.39 (4.52)	39.41 (3.16)	$F(1, 62) = 9.178, p = .004, \eta_p^2 = .129^*$
Weight (KG)	71.78 (12.30)	63.01 (7.33)	$F(1, 55) = 10.586, p = .002, \eta_p^2 = .161^*$
BMI	25.61 (4.67)	22.12 (3.14)	$F(1, 55) = 10.886, p = .002, \eta_p^2 = .165^*$

Note. *Significant Result.

^a A Bayes model comparison was conducted to evaluate the evidence in favour of the body image level model versus the null model. The prior probability for each model was set to 0.50. The posterior probability for the body image level model was 0.561, while the posterior probability for the null model was 0.439. The analysis yielded a Bayes Factor of $BF_{10} = 1.00$, indicating that the data provides equal support for both the body image level model and the null model. The error percentage for the Bayes Factor estimate was 0.01%. Therefore, we are not interpreting this finding as statistically significant.

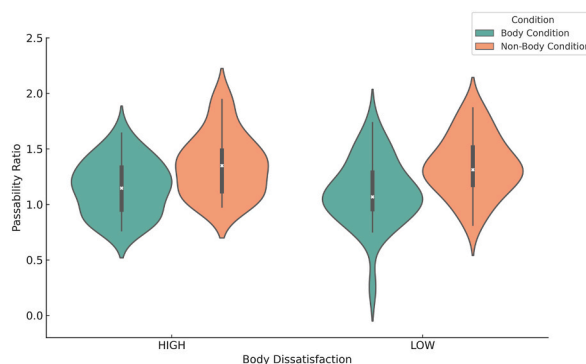


Fig. 4. Violin plots depicting passability ratios for the high and low body dissatisfaction groups in the body and non-body aperture conditions. Repeated-measures ANOVA revealed a significant main effect of aperture type, with higher passability ratios in the non-body condition compared to the body condition. No significant interaction between aperture type and group was observed. Error bars represent ± 1 SE.

type and body image group ($F(1,62) = 5.90$, $p = .018$, $\eta^2 = 0.087$). Post-hoc comparisons indicate significant differences in JNDs between the body and non-body condition in the low body dissatisfaction group ($t = -3.614$, $SE = 0.329$, $p = 0.004$) with the non-body aperture having higher JNDs ($M = 4.60$, $SD = 2.19$) than the body aperture ($M = 3.41$, $SD = 2.03$). See Fig. 5 for a visualisation of the ANOVA result.

6.1. Exploratory analysis

Exploratory Pearson's R correlations were conducted between the PACS-R, VMIQ-2, MAIA-2 sub-scales, passability ratios, and JND scores in the body and non-body conditions. The full reported correlations are presented in Supplementary Fig. 1. Notably, significant positive correlations were found for JNDs in the body condition with self-comparison scores ($r = 0.283$, $p = .023$). Negative significant correlations were found for JNDs in the body condition with the Trusting sub-scale of the MAIA-2 ($r = -0.348$, $p = .005$). There were no significant correlations between passability ratio scores and JND scores in the non-body condition and other questionnaire measures.

7. Discussion

This study investigated if viewing bodies in an environment influences body schema distortions in women with high and low body dissatisfaction. Contrary to expectations and previous research [34], participants imagined their bodies to be larger than they were when asked to imagine walking through non-body apertures compared to the body apertures. Whilst there was an overestimation of passability for both aperture types, participants were more accurate at estimating passability for body apertures.

Previous research has demonstrated that individuals are good at identifying and accounting for the aperture passability of other people [34]. Research also suggests that overestimations of passability typically occur when the penalty for error is high [47]. For example, Comalli et al. [47] demonstrated that individuals were more conservative when deciding to pass through apertures when the penalty for error was falling off a ledge, compared to apertures without a fall risk. Therefore, in our study, it is plausible that participants may have perceived collisions with the poles as more uncomfortable than with humans due to the solid edges, which may

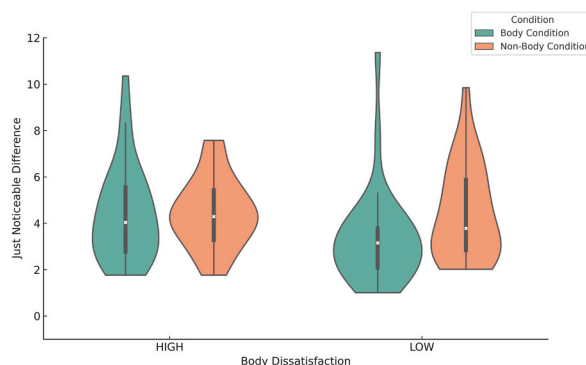


Fig. 5. Violin plots depicting JND scores for the high and low body dissatisfaction groups in the body and non-body aperture conditions. Repeated-measures ANOVA revealed a significant main effect of aperture type, with higher JNDs in the non-body condition compared to the body condition. A significant aperture type $\times$ group interaction indicated that this difference was driven by the low body dissatisfaction group, who showed higher JNDs for non-body than body apertures. Error bars represent ± 1 SE.

have contributed to the overestimations of space to pass through the columns.

Contrary to previous studies on individuals with Eds [11] and some with healthy women [23], there were no differences in aperture passability judgements between women with high and low body dissatisfaction, regardless of whether the apertures involved body or non-body configurations. This finding is mirrored in some studies investigating women in the general population which report that body image does not influence aperture passability decisions in individuals without Eds [21]. Despite this, certain task-specific factors may have influenced this finding. For instance, the slender avatars presented to participants may have temporarily increased state body dissatisfaction, even among those with low trait body dissatisfaction. Indeed, Aniulis et al. [25] found that state body dissatisfaction was significantly associated with passability judgments, suggesting that potential unmeasured fluctuations in state body dissatisfaction may have contributed to the similar passability ratios observed between groups in our study. Additionally, our study assessed only attitudinal, rather than perceptual, BID. Perceptual BIDs may exert a more direct influence on tasks involving body-scaled action judgments, such as estimating aperture passability. Indeed, Irvine et al. [23] found that perceptual BID correlated with passability ratios in the aperture task among individuals with pronounced negative body attitudes. This suggests that, in women without EDs but with high body dissatisfaction, perceptual BID may be more strongly associated with passability estimates than attitudinal BID alone. Finally, the absence of group differences in passability ratios may partly reflect sample composition factors such as BMI. In our study, participants' BMIs across groups ranged from healthy to overweight. However, prior research suggests that individuals with low/underweight BMIs are more likely to overestimate their body size regardless of body image concerns; a phenomenon known as *contraction bias* (See: Cornelissen et al., [48], Wignall et al., [22]). This bias has been proposed to explain greater passability ratios in the aperture task in individuals diagnosed with anorexia nervosa (Glashouwer et al., [21]).

However, this study found group differences in the precision of passability judgments (JNDs) for body apertures, with women high in body dissatisfaction showing poorer precision and greater uncertainty than those low in body dissatisfaction. This finding aligns with a study by Talbot et al. [49], who found that higher JNDs for muscularity categorization judgments in men were positively correlated with weight concerns, i.e. participants with greater weight concerns were less precise in their perceptual categorization of body muscularity. This finding also supports the ALH, suggesting that body schema disturbances may arise from perceptual uncertainty driven by heightened attention to the external, objectified body at the expense of internal bodily signals. Indeed, women with higher body dissatisfaction exhibited lower interoceptive sensibility, particularly in body listening and body trusting, than those with low body dissatisfaction. This suggests that BID in the general population may cause perceptual uncertainty regarding their body size, which could predispose individuals to more pronounced body schema alterations, as observed in patients with EDs.

Interestingly, while the low body dissatisfaction group showed greater precision for body than non-body apertures, those with high body dissatisfaction demonstrated similar precision across both. Research suggests that people typically show an attentional advantage for body stimuli over non-body objects [50]. Thus, the absence of this effect in individuals with high body dissatisfaction may indicate that they process bodies more like objects, reflecting objectified body processing. This aligns with research on individuals with EDs, who tend to process body-related stimuli in a disembodied manner, often perceiving their bodies similarly to how they would perceive objects [16]. One explanation, objectification theory, posits that women with high body dissatisfaction view themselves from an observer's perspective, primarily evaluating themselves based on their appearance [51]. Research also indicates that women who self-objectify also take an objectified perspective on other people's bodies [52]. Therefore, participants in the high body dissatisfaction group in our study may have perceived the body apertures in an objectified manner.

Interestingly, the exploratory analysis indicated that lower precision of passability judgements in the body aperture condition was correlated with higher appearance comparison scores. Therefore, women with significantly higher levels of appearance comparison (predominantly found in the high body dissatisfaction group) may have experienced increased uncertainty about aperture passability due to comparisons with the body avatars, resulting in lower precision. This also aligns with the findings of Aniulis et al. [25], who found that passability judgments through apertures formed by underweight women were correlated with body dissatisfaction in women without EDs. Appearance-focused social comparisons are thought to occur automatically, driven by neural mechanisms that process others' bodies relative to one's own [53]. Research on attentional bias suggests that individuals with high body dissatisfaction selectively attend to appearance-related cues, prioritising body-relevant information while suppressing non-body cues [28]. Given that the avatars used in the present study were slender, it is possible (based on exploratory findings) that participants directed greater attention toward the avatars' bodies rather than the spaces between them, which may have contributed to increased uncertainty in their passability judgments. Interestingly, a study by Piryankova et al. [54] found that viewing either an overweight or an underweight avatar from a third-person perspective prior to completing the aperture task did not significantly alter passability ratios in healthy participants. However, multiple factors like perceptions of avatar attractiveness, body size, or self-other avatar specific body comparison could have also influenced passability judgments. Future studies should assess these factors explicitly and consider using more diverse or customisable avatars to better account for potential perceptual and affective influences on task performance.

The study also found that higher body dissatisfaction was associated with lower motor imagery vividness from both internal and external perspectives, and greater appearance comparison was linked to reduced vividness in external imagery across the full sample. This finding is supported by research indicating that individuals with BIDs report lower vividness of mental imagery [8]. According to Lorey et al. [55], external motor imagery entails a visual representation of movement appearance, which could rely on body image, while internal motor imagery involves forming an internal motor plan based on the body schema. Therefore, the diminished vividness in both external and internal motor imagery among individuals with higher attitudinal BID suggests a possible disruption in both body image and body schema, highlighting a functional relationship between these two constructs. Notably, no significant differences were observed in the high and low body dissatisfaction groups in the lab sample, indicating that mental imagery vividness was not a covariate in their passability judgements.

Individuals with high body dissatisfaction and appearance comparison also reported lower interoceptive sensibility, aligning with

existing research that links BID to reduced awareness of internal bodily signals [6]. Interestingly, lower interoceptive sensibility across all domains was also associated with diminished vividness of external, internal, and kinaesthetic imagery. This is in line with recent work by Malloggi et al. [56], who found that higher scores on the MAIA-2 were linked to higher motor imagery vividness in the visual and kinaesthetic modalities. Indeed, higher interoceptive abilities have been linked to more coherent mental representations of the self [6]. Interestingly, the exploratory analysis indicated that the MAIA-2 Trusting subscale was significantly associated with greater uncertainty in judging passability through body apertures.

Some research has linked altered interoception to altered body representation. For example, Tsakiris et al. [19] found that lower interoceptive sensitivity was linked to greater susceptibility to embodying a rubber hand (i.e. the rubber hand illusion). Alternatively, Baumann et al. [57] found that heightened interoceptive awareness of hunger was linked to larger passability estimates in the aperture task. Whilst previous research has linked the Trusting sub-scale of the MAIA-2 to measures of body image [6], this exploratory analysis provides the first evidence of the Trusting sub-scale linked to the body schema. However, the specific relationships between other features of interoceptive sensibility and body schema remain unexplored.

8. Limitations and future directions

A potential limitation of the study is that it is unknown the extent to which participants made their estimates based on directly comparable points in the aperture conditions. The study expected that participants would base their passability estimates for body apertures using the shoulder width as the reference point on the distance between two avatars as they were instructed to imagine trying to pass through without rotating their own shoulders. However, participants might have used alternative reference points, such as the distance between the avatars hips or knees, to make their passability estimates for body-based apertures. The apertures were scaled to match participants' heights to mitigate potential variability in reference point selection. In line with research that suggests that eye-height information is typically used to assess aperture passability [44]. Additionally, our sensitivity analysis confirmed that significant differences at the top half of both apertures only existed when comparing shoulder distances between the body apertures to the non-body apertures. However, future studies should ensure that body-based apertures are uniform in shape. This can be achieved by using columns or other structures that mirror the geometric shapes of body apertures, controlling for the influence of varying distances presented by different parts of the body-based aperture forms (e.g. shoulder-shoulder, hip-hip). A further limitation is that the Part A sample seemed to have elevated appearance comparison scores which could reflect the age profile of the sample, as most participants were young adult women, a group in which appearance-related concerns and comparisons may be more common [20]. Furthermore, it is important to acknowledge the relatively small sample size used in Part B of the study. Although the power analysis indicated that this sample was sufficient to detect a large effect, future studies should aim for larger samples to ensure adequate power to detect small-to-medium effects.

It is also important to note that we did not account for participants' peri-personal space, which may have influenced their performance. Research suggests that individual differences can influence the flexibility of peri-personal space [31]. Interestingly, passability estimates were more precise in the avatar condition than in the column condition, contrasting with previous findings where apertures using actual humans lead to more liberal passability estimates [34]. Additionally, controlling avatar characteristics in VR is important, as avatar attributes and how they are perceived by participants may also influence spatial judgements. Avatar attributes and how they are perceived may influence interpersonal distance in virtual environments [58]. Thus, future research should carefully select avatar stimuli and assess participants' perceptions to better account for such effects. As VR avatars represented the body apertures, participants might not have accounted for peri-personal space in the same way they would with actual human figures. Considering that previous research indicates that participants often maintain real-world norms including interpersonal distance in virtual environments [58], future research should explore whether passability estimates vary between scenarios involving real humans versus virtual avatars. Finally, the passability estimate does not accurately measure the width at which participants would actually start to turn sideways to walk through a real aperture. While motor imagery tasks are useful and suitable for evaluating body schema [59], future research should investigate how body dissatisfaction influences actual passability through apertures using motion tracking technology to better understand the body schema during movement. Additionally, in line with the ALH, potential therapeutic applications to ameliorate BIDs could incorporate VR to simulate exteroceptive body interactions (e.g., passability or spatial judgment tasks) alongside interoceptive training to enhance overall embodiment. Indeed, recent research suggests that interventions targeting embodiment through sequential mirror exposure and mindfulness-based exercises (integrating interoceptive and exteroceptive processes) can effectively reduce body dissatisfaction [60]. Overall, this study offers a novel contribution to the ongoing question of whether BID is linked to an altered body schema in individuals without EDs. The study also highlights the role of contextual factors in the relationship between BID and body schema, emphasizing that disturbances in body schema may emerge in specific contexts (e.g. when navigating bodies vs objects in the environment). Additionally, we provide evidence that body dissatisfaction in individuals without EDs may be related to precision and certainty of body size during motor imagery as opposed to an overt enlarged body schema that is found in individuals with EDs.

CRedit authorship contribution statement

Akansha M. Naraindas: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Pat Mulvaney:** Writing – review & editing, Software, Methodology, Conceptualization. **Rosie Rogers:** Writing – review & editing, Project administration, Investigation, Data curation. **Deirbhle Fergus:** Writing – review & editing, Project administration, Investigation, Data curation.

Brendan Rooney: Writing – review & editing, Conceptualization. **Sarah M. Cooney:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization.

Ethics and consent statement

The study received ethical approval from the Human Research Ethics Committee at University College Dublin (Reference: HS-23-36-Naraindas-Cooney) on May 25th, 2023, and was conducted in accordance with the ethical standards outlined in the 2013 Declaration of Helsinki. All participants provided written informed consent prior to taking part.

Data availability statement

The datasets generated during and/or analyzed during the current study are available on OSF: <https://osf.io/w84zq>.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2026.e45274>.

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