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Body size aftereffects are adult-like from 7 years onward

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ABSTRACT

There is considerable evidence that adults' perception of body weight in others can be manipulated via visual exposure to multiple bodies at one or another weight extreme. No study has yet examined how early in childhood such visual adaptation aftereffects exist. We ran experimental adaptation tests with predominantly White British 11- and 12-year-olds, 14- and 15-year-olds, and adult men and women (Study 1; $N = 181$) and with 7- and 11-year-olds and adults (Study 2; $N = 110$). Participants viewed bodies ranging from low to high weight before and after being adapted to bodies with very low or very high body mass. Participants of all ages showed a significant change in their weight estimates after being adapted to larger bodies (but not to smaller bodies), suggesting that this aspect of body perception is functionally mature by 7 years.

Introduction

A substantial body of literature has demonstrated that perception of third-party body size can be manipulated by visual exposure to bodies of very low or very high weight. These effects have been demonstrated in Western laboratory studies with regard to body size attractiveness (Boothroyd

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et al., 2012; Glauert et al., 2009; Stephen & Perera, 2014; Winkler & Rhodes, 2005), body size normality (Glauert et al., 2009; Stephen et al., 2016, 2018; Winkler & Rhodes, 2005), and perceptions of a healthy weight (Robinson & Kirkham, 2014; Stephen & Perera, 2014), and have been replicated in low-media samples in rural Nicaragua (Boothroyd et al., 2020). These effects are robust against experimental instructions to participants that direct attention to aspects of the body other than weight (Stephen et al., 2016). Furthermore, participants who spontaneously attend more toward low-weight versus high-weight bodies (i.e., those with preexisting body weight concerns) may show stronger impacts of visual exposure (Stephen et al., 2018).

All the above research has focused on adult participants, with a strong bias toward undergraduate samples. Research into facial aftereffects, however, has demonstrated that aftereffects with complex social stimuli can be observed in childhood too. Both facial identity and facial attractiveness aftereffects can be seen in children as young as 5 years (Anzures et al., 2009; Jeffery et al., 2010; Nishimura et al., 2008; Short et al., 2011). Although the underlying neural responses to facial adaptation paradigms is still maturing until at least 10 years of age (Cohen Kadosh et al., 2013), broadly speaking the adaptation effects in these studies did not differ between children and adults. It was the case however, that Anzures et al (2009) needed to use stimuli with a stronger distortion in children to induce variability in perceptions of attractiveness to begin with, whereas Nishimura et al. (2008) found that the children had weaker overall recognition performance. This suggests that we would likely also observe body size aftereffects in childhood, albeit perhaps with some differences from adults.

Research into adaptation to body stimuli, however, is lacking in children. In terms of weight perceptions, there is tangential evidence from the body image literature. Although the current studies focused on general perceptions of third-party (adult) body stimuli rather than body dissatisfaction or evaluative endorsement of thin ideals, perceptions of the "ideal" body nevertheless include a perceptual component and some body image studies measure this ideal. Given that ultra-thin fashion dolls are stimuli consisting of low-weight artificial female bodies, visual engagement with these dolls may shift perceptions of the ideal body weight. Most studies of doll viewing or doll play only report the discrepancy between perceived own body and idealized body. However, Boothroyd et al., (2021) observed that playing with ultra-thin dolls led to a decrease specifically in the size of body girls indicated as their ideal self in an interactive figure choice task. Thus, it is *possible* that the visual experience affected internalized perceptual representations of body weight in these children, as seen in adult adaptation paradigms. However, to our knowledge no study has directly assessed body size adaptation aftereffects in children or adolescents—either using the same paradigms as those used with adults or even using similar methods, as is done in the children's facial adaptation literature.

When considering general perceptions of body shape across development, a preference for adult-like waist:hip ratios (i.e., smaller in women than in men) emerges in the peri-pubertal period and is mature by approximately 14 years of age (Connolly et al., 2004). In contrast, some other aspects of body perception, such as holistic processing, seem to be adult-like as young as 6 years; adults and children both show similar inversion and composite effects in body perception, although adults were overall more likely to correctly respond to both normal-view and inverted/non-aligned stimuli (Butti et al., 2022). This contrast in behavioral data is broadly concordant with the mixed evidence of neurological development, where data collectively show that body-selective regions of the brain may be evident by 7 years of age, with some studies suggesting early maturation (Peelen & Downing, 2005; Pelphrey et al., 2009) and others showing increasingly adult-like activation and connectivity patterns across childhood and adolescence (Fontan et al., 2017; Ross et al., 2014, 2019). Therefore, it was an open question whether we would see adult-like responses to a body size adaptation paradigm from as young as 7 years, consistent with the early-maturation perspective, or whether these responses would show a pattern of being increasingly adult-like through the first and second decades of life.

The current studies therefore sought to test the effects of visual exposure to high- or low-weight bodies on perceptions of weight (from very underweight or very overweight) in children, adolescents, and adults in order to establish whether the experimental impact of visual exposure differed among these groups. Study 1 examined these effects in early adolescents (11–12 years), mid-adolescents

(14–15 years), and young adults (undergraduate students). Study 2 examined the effect in younger children (7- to 11-year-olds) and a similar student comparison sample. In both studies, participants viewed images of female bodies ranging from low to high weight and were asked to rate that weight on a Likert scale before and after seeing a series of bodies that were biased to include predominantly very low-weight stimuli or predominantly very high-weight stimuli.

There are two forms of outcomes that would indicate adaptation has occurred. Many authors have described adaptation effects with faces and bodies as due to changes in a central ''prototype" from which all faces (or bodies) are coded (norm-based coding; see, e.g., Jeffery et al., 2010; Rhodes, Jeffery, Boeing, & Calder, 2013). Under that model, adaptation to emaciated bodies should make all bodies look comparatively larger because the prototype becomes thinner, whereas adaptation to very large bodies should make all bodies look comparatively thinner, because the central prototype has shifted to be larger. Alternatively, body size adaptation aftereffects may arise due to localized short-term changes in the neural clusters coding for bodies of particular (ranges of) sizes, consistent with the fact that nonhuman relative shape dimensions such as wide versus tall ovals are perceptually represented via multichannel coding (Storrs & Arnold, 2017; see Boothroyd et al., 2018, for discussion of this in body attractiveness aftereffects). Under that approach, we would expect to see aftereffects that are specific to the end of the weight spectrum to which participants are adapted; that is, those viewing emaciated bodies should view thinner bodies as larger without changing their perceptions of larger bodies, whereas those viewing very large bodies should see larger bodies as thinner at posttest without changing their perceptions of thin bodies. Crucially, the focus of the current studies was not which of these kinds of aftereffects are observed but rather whether we see the same results in children versus adults. If the visual component of weight perception is mature early as with holistic processing, we should see the same pattern of results in adults, adolescents (Study 1), and children (Study 2). If, however, this aspect of third-party body perception matures later as with perceptions of attractiveness in gendered bodies, we should see increasingly adult-like aftereffects as children age.

Study 1

Method

Ethics

Ethical approval was granted by the psychology departmental ethics committee at Durham University. Positive written parental consent procedures were used for adolescent participants, with additional participant assent during testing (indicated by button press in the computerized task).

Participants

Adolescent participants were recruited through a Catholic high school in an area of moderate economic deprivation in Northern England. Parental consent was sought from two classes in each of Year 7 and Year 10. Those for whom consent had been received and who were in school on the day of testing completed the study in class groups. Participants self-reported their age in years and gender. In total, 44 11- and 12-year-olds (mean age = 11.9 years, *SD* = 0.3; 25 girls and 17 boys, 1 'other', 1 non-response) and 59 14- and 15-year-olds (mean age = 14.8 years, *SD* = 0.4; 31 girls and 28 boys) were tested. A further 78 18- to 25-year-olds (mean age = 20.1 years, *SD* = 1.6; 68 women and 10 men) were recruited online through the university's psychology department participant pool and received partial course credit. Overall, 83% of participants were White, 8% were Chinese, and the remainder included Black, Hispanic, other Asian, and other ethnicities.

Stimuli

Images were drawn from a set of 50 color images of female bodies of known body mass index (BMI) photographed in a standardized pose and a gray leotard outfit, with faces obscured by a black oval (Tovée et al., 1999). The set consists of 10 bodies in each of five BMI ranges (11–15, 15–19, 20–24, 25–30, and 30–42 kg/m^2).

Procedure

Child participants participated in a computer classroom, with each child using a separate computer. The experiment was run through a web-based test interface, and participants were directed to the link by the experimenters. Adult participants were sent the study information and link via the participant pool e-mailing tool, and they completed the study on their own device in their own homes or in a university computer room. All participants first reported their demographic characteristics and then proceeded to the body test itself. Written instructions told the participants, "You will now be shown a series of images of bodies. Please rate each body from 1 (very underweight) to 7 (very overweight)." From the participants' perspective, the body test, adaptation and re-test process consisted of rating the weight of a continuous stream of images without obvious disjunctions between blocks. Images were presented at a standardized width of 400 mp (height varied slightly depending on the height of the woman pictured) in the center of the test window.

In the pre-adaptation phase, participants viewed 21 images in the BMI range of 12 to 32 kg/m^2 based on selecting alternate images from the BMI-ranked full stimuli set within that range. They were then randomized into two conditions; half were presented with 20 images with BMIs ranging from 11.60 to 13.84 (thin condition; mean BMI = 12.8) that were the previously unseen 5 images from the bottom weight category repeated four times, whereas half were presented with 20 images with BMIs ranging from 30 to 42 (large condition; mean BMI = 35.5) that were the 10 bodies from the highest weight category repeated twice. As such, other than one body in the large condition (which was also the highest-weight body in the test stimuli), adaptation stimuli were different from test stimuli. Finally, participants viewed the same 21 images as at pretest, interspersed with 20 top-up trials of the adaptation phase stimuli. Order of test and top-up stimuli at post-test was fully randomized. For all trials (test trials and adaptation/top-up trials), participants rated the body's weight on a 7-point Likert scale ranging from *very underweight* to *very overweight*, positioned immediately under the image. The image remained on-screen until the participant gave a response, and then the next image was automatically presented with a brief (<1 s) interval while it was loaded by the app. The experimental paradigm and example images are shown in Fig. 1.

Analyses

Data were analyzed in R (R Development Core Team, 2021) using the "lme4" package (Bates et al., 2015) and the "stargazer" package (Hlavac, 2018) in RStudio. Data and code are included as

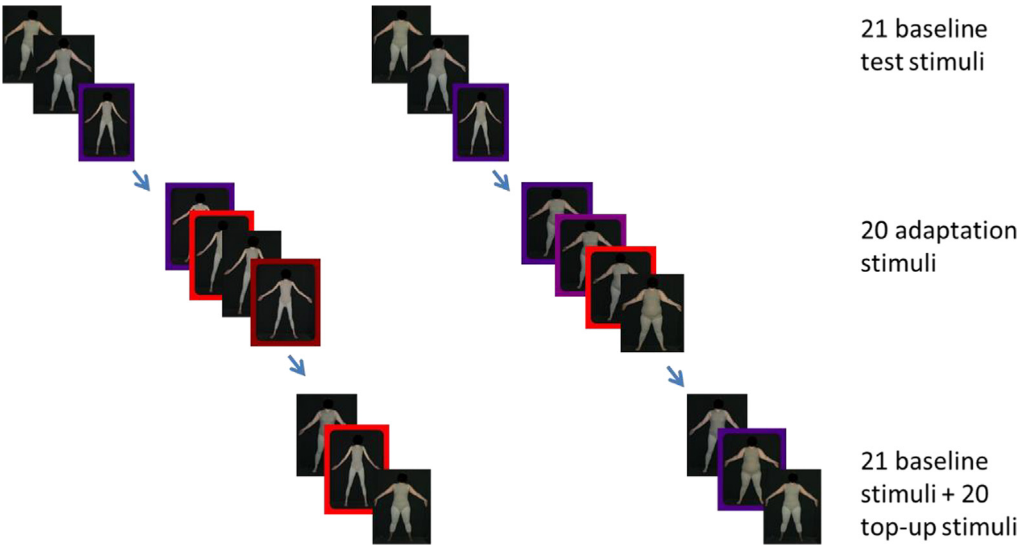

Fig. 1. Schematic of experimental design for Study 1 showing the thin condition (left) and the large condition (right).

supplementary material. Test trial data were entered into a random intercept mixed-effects linear model, clustered by participant, with BMI and time as trial-level predictors and age group and condition group as participant-level predictors. Condition group and time were effect coded, while age group was entered as a categorical variable (reference category: 12 year olds). We predicted a roughly linear association between stimulus BMI and perceived weight, and so we examined two elements of that linear association. First, we examined changes in the regression estimate for Time × Group in the function for perceived weight regressed onto BMI; if there was a change in the central prototype of a body, we would expect to see a shift such that those viewing thinner bodies should see all bodies as a heavier weight at posttest than at pretest and vice versa. We also looked at the regression estimate for Time × Group × BMI; if change in perceptions is predominantly restricted to the weight range close to the viewed stimuli, we should see that the Time × Group effect becomes more evident at higher stimulus BMI levels for those viewing larger bodies and vice versa. Finally, by including the interaction between these effects and age group, we assessed whether any of these effects was subject to moderation by participant age (e.g., weaker adaptation in younger groups) or whether they were statistically comparable across groups.

Results and interim discussion

Predictors were entered into the model described above in stages, with image BMI and group main effects entered first, followed by time (pre vs. post) and the interactions with group and image BMI, followed by the main effect of, and interactions with, participant age group.

Results of these models are shown in Table 1. Model 1 showed an expected main effect of image BMI such that large images were rated as heavier. Adding time and the Group × Time and Group × Time × BMI interactions in Model 2 significantly improved the model. There was a significant

Table 1
Linear models of the experimental effect of high vs low weight body exposure on body weight perceptions.

	Model 1		Model 2		Model 3	
	Est.	SE	Est.	SE	Est.	SE
Constant	3.430**	(0.031)	3.426**	(0.031)	3.366**	(0.061)
Image BMI	0.256**	(0.002)	0.255**	(0.002)	0.256**	(0.002)
Group	−0.479**	(0.058)	−0.485**	(0.058)	−0.492**	(0.060)
Time			−0.224**	(0.019)	−0.220**	(0.020)
Group × Time			−0.343**	(0.039)	−0.276**	(0.081)
Age group (ref = 12yos)						
14–16 year olds					0.133	(0.080)
Students					0.034	(0.077)
Group × Time × Age group (ref = 12yos)						
14–16 year olds					−0.094	(0.107)
Students					−0.067	(0.101)
Image BMI × Group × Time			−0.007	(0.006)	−0.076**	(0.015)
Image BMI × Group × Time × Age group (ref = 12yos)						
14–16 year olds					0.084**	(0.019)
Students					0.084**	(0.017)
Observations	11046		11046		11046	
Log Likelihood	−14,068.86		−13,975.26		−13,959.77	
Akaike Inf. Crit.	28,147.71		27,966.52		27,947.53	
Bayesian Inf. Crit.	28,184.26		28,025.00		28,049.87	

Note. BMI, body mass index; ref, reference; AIC, Akaike information criterion; BIC, Bayesian information criterion.
*$p < .05$.
** $p < .01$.
***$p < .001$.

Group × Time interaction effect, such that test stimuli were rated as lower weight by participants in the 'large' group at post-test. Adding in the interactions with age group in Model 3 only slightly improved the model but did show a 4-way interaction for Group × Time × BMI × Age group. Additional models (see supplementary material) showed that the two-way Time x Group interaction was present in all age groups, but that for 12-year-olds, the effect of viewing the larger bodies was stronger (more negative) at the upper weight range (3-way BMI × Group × Time interaction: $B = -0.076$, $p < .01$). As can be seen in Fig. 2, the average participant response in the thin condition (in red) produced almost identical regression functions at pre- and post-test, whereas the regression line was clearly different for the large condition (in blue), with more divergence at the upper weight range for the 12-year-olds in particular. (For the students, the blue lines do show divergence but there is some slight divergence in the slopes for the red lines in the same direction, and hence we see no 3-way interaction).

Study 2

Method

Ethics

The project was given ethical approval as part of a large research event in which children took part in multiple research projects across the day in exchange for tokens that could be 'spent' on taking turns in games and virtual reality experiences. Parents gave consent for the children to participate in the research tasks in general. The current study, because it involved a theme related to body image, was consented separately, and experimenters were able to check children's ID badges to ensure that children took part only if they had parental consent to do so. A responsible adult for each child was always present, and children verbally assented to participation. Adult data were collected under a separate ethics approval.

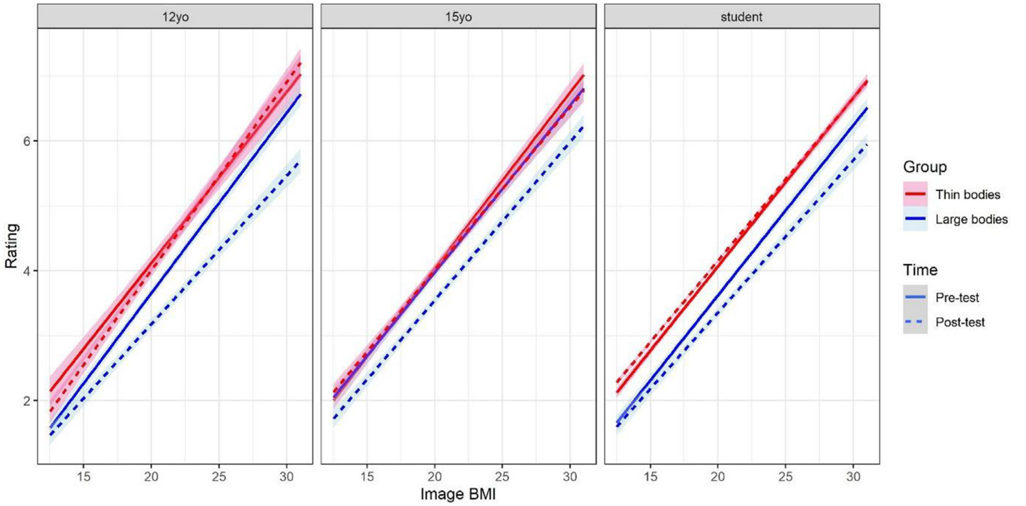

Fig. 2. Linear association between image body mass index (BMI) and rated weight (1 = *very underweight*, 7 = *very overweight*) by group (red = thin body exposure, blue = large body exposure) at pre-test (solid lines) and post-test (dotted lines), split by age group (12yo, 11 and 12 years old; 15yo, 14 and 15 years old; student, adult undergraduate student). Shading shows 95% confidence intervals. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.).

Table 2
Linear models for experimental effect of body exposure (thin vs large) in Study 2.

	Model 1		Model 2		Model 3	
	Est.	SE	Est.	SE	Est.	SE
Constant	3.288**	(0.032)	3.333**	(0.033)	3.457**	(0.050)
Image BMI	0.139**	(0.001)	0.146**	(0.001)	0.145**	(0.001)
Group	−0.200**	(0.063)	−0.151*	(0.066)	−0.155*	(0.063)
Time			−0.095**	(0.017)	−0.094**	(0.017)
Group × Time			−0.382**	(0.038)	−0.498**	(0.060)
Age group (ref = 7-11yos)					−0.207**	(0.065)
Group × Time × Age group					0.193*	(0.077)
Image BMI × Group × Time			−0.0001	(0.005)	−0.008	(0.008)
Image BMI × Group × Time × Age group					0.014	(0.010)
Observations	6,510		4,970		4,970	
Log Likelihood	−6,215.81		−4,558.89		−4,550.85	
Akaike Inf. Crit.	12,441.63		9,133.78		9,123.71	
Bayesian Inf. Crit.	12,475.53		9,185.86		9,195.33	

Note. BMI, body mass index; ref, reference; AIC, Akaike information criterion; BIC, Bayesian information criterion.
* $p < .05$.
** $p < .01$.

Participants

A total of 51 children were recruited; of these, 7 children (all aged 7 or 8 years) were excluded prior to data analysis because they stopped engaging due to boredom, gave apparently random or patterned answers (e.g., 1, 2, 3, 4, 5, 1, 2, . . .) at baseline suggesting they could not judge body weight (see "Procedure" section for how this was managed), or indicated to the experimenter that they were using something other than weight to make their judgments (e.g., "heavy is when they're [mimes tall]"). This left 44 children aged 7 to 11 years (mean = 8.6 years, *SD* = 1.2; 22 boys and 22 girls). A total of 66 undergraduate students (61 women, 4 men, and 1 non-binary; mean age = 18.7 years, *SD* = 1.3) who received partial course credit were recruited from the department participant pool. Participants were not asked their ethnicity, but all but 3 child participants were observed to be White. Adult participants reported their normal country of residence (when they were not attending university); 80% lived in the United Kingdom, 15% lived in China, and the remainder lived in other countries.

Procedure

Because Study 2 ran as part of a larger research event, with children aged 7 years and up, a slightly modified procedure was used. The most emaciated bodies were not used as stimuli, and we used a simpler 5-point Likert scale from *very thin* to *very heavy*. The procedure was also shortened by removing the post-test top-up trials, and a short "wash-out" phase was included at the end where the children were shown healthy-weight characters from *Illumination* studios films and asked whether they liked them or not. As a result, at pretest participants viewed 22 bodies with BMIs ranging from 14.7 to 37.4, again alternating images from this range when ordered by weight. In the adaptation phase, those in the thin condition viewed 20 bodies with BMIs ranging from 13.5 to 15.8 (mean = 14.8), and those in the large condition were shown bodies with BMIs ranging from 31 to 42 (mean = 35.5). All participants then viewed the pretest stimuli again.

Children were tested individually in person while the experimenter sat beside them at a laptop. Children were told that they were going to be shown some pictures of bodies and that we would like them to tell us how heavy each one was. Children had a written reminder of what each point on the Likert scale meant in front of them, and each point was explained verbally by the experimenter (1 = "very thin or very skinny," 2 = "thin," 3 = "in the middle," 4 = "heavy," and 5 = "very heavy"). Children verbally gave their rating for each image, and the experimenter manually entered the ratings on the computer, which advanced the program to the next image. One child pointed to the number on the written scale without verbalizing. As in Study 1, the images stayed on-screen until the response

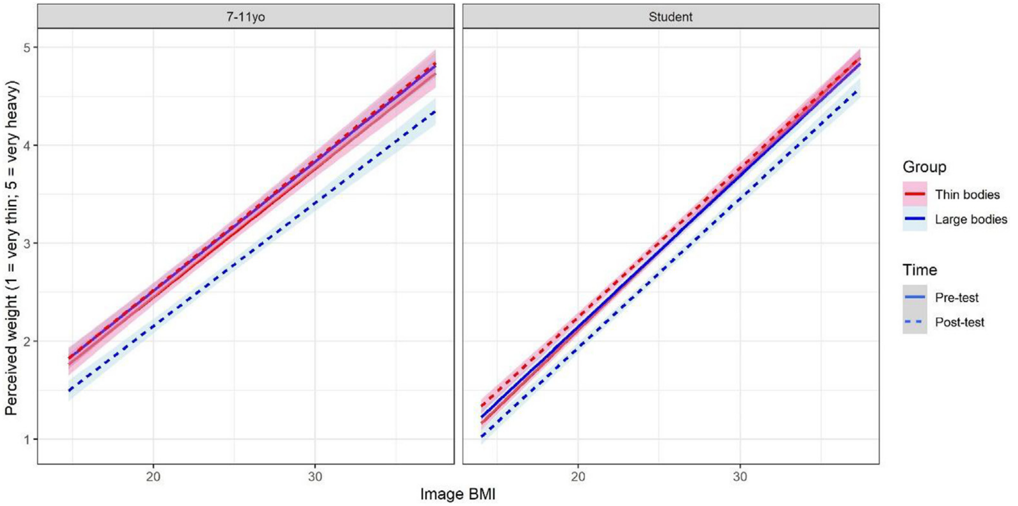

Fig. 3. Linear association between image body mass index (BMI) and rated weight in Study 2 by group (red = thin body exposure, blue = large body exposure) at pretest (solid lines) and posttest (dotted lines), split by age group (7-11yo, 7–11 years old; Student, adult undergraduate student). Shading shows 95% confidence intervals. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.).

was given, and trials appeared to run as one continuous sequence. When children seemed to be giving contradictory responses, the experimenter would ask once, "So this person is thinner/heavier than the last one?" to check understanding. Whatever the children's response, the experimenter replied "okay" and carried on. Children who gave contradictory responses were noted at the end of testing and were excluded prior to compiling the final dataset.

Adult participants followed a link on their own devices from the participant pool system and completed an identical procedure online but without the wash-out phase, with information given in writing and inputting their own responses on a 5-point scale beneath each image. They were informed at the start of the study, "You will view a series of photographs of (dressed) human bodies and indicate your perception of the size of each image," and each body was accompanied by the question "How heavy is this body?" with the Likert scale underneath.

At the end of the study, children were thanked and given a token to take to the games area, and adult participants were automatically redirected to the participant pool system, which granted their participation credit.

Results and interim discussion

As in Study 1, random intercept models were used to test the effects of image BMI, condition group and age group, and time point on weight perceptions in sequential models. We again saw a significant interaction between group and time (see Model 2 in Table 2). As shown in Fig. 3, participants in both age groups who had seen the heavy bodies during the adaptation stage rated all images as lighter at posttest versus baseline. Introduction of participant age group in Model 3 did not eliminate the significant Group × Time interaction but did introduce a significant three-way interaction with age group. This was further investigated in separate models for the 7- to 10-year-olds and the undergraduate students. As shown in the supplementary material, when analyzing the two age groups separately, the two-way interaction between group and time existed in both groups and if anything was stronger in the children than the students (B = –0.492 vs –0.305).

Finally, an exploratory analysis tested whether child age affected the strength of the Group × Time interaction effect. Results are shown in the supplementary analysis output in the supplementary material, and they demonstrate that the experimental Time × Group interaction was present from 7 years of age ($B = -0.335$, $p < .001$), with no interaction with child age. When the 7- and 8-year-olds were isolated and compared with adults, there was no evidence that the Time × Group interaction was significantly different in the younger children versus the adults (three-way interaction: $B = 0.090$, $p > .10$). Overall, therefore, these data show effectively the same pattern in the children and adults: Viewing large bodies made all bodies (thin and large) look lighter at post-test.

The key difference between Study 1 and Study 2 therefore is that the experimental effect in Study 1 was moderated by the BMI of the image in one age group, being more effective at the upper weight range for the younger participants, whereas in Study 2 the effect was consistent across the weight range in both age groups. This difference may be due to the difference in stimuli used across the studies. Scatterplots for Study 1 (see supplementary material) show an "anchoring" effect of the emaciated bodies on weight ratings which were already at floor at pre-test. By excluding these images in Study 2 for ethical reasons (running the test at an open research day, with younger children and less chance for debriefing and thus exclusion of higher risk images), we likely also excluded a range of images that some participants would always rate as *very underweight* because they are so emaciated. It is also possible that changing the verbal label from very underweight to very thin may have had an effect on how younger participants used the scale.

General discussion

The current research sought to test the extent to which perceptual body weight aftereffects can be found in children as well as adults. Matching experimental procedures were used to test the effect of concentrated exposure to low- or high-weight bodies on the rated weight of test stimuli with adolescents and adults (Study 1) and with children and adults (Study 2). Both studies found that viewing larger bodies lowered weight estimates in both the child/adolescent and adult participants, with evidence that this effect was equally (or more) robust in 7-year-olds as in adults.

This strongly suggests that this aspect of body weight perception is functionally mature by 7 years of age and aligns with those researchers who argue that other aspects of person perception such as face processing are likewise mature before puberty (e.g., McKone et al., 2009; but cf. Susilo et al., 2013). Our results are also consistent with prior literature showing that facial adaptation can be demonstrated early in childhood. However, unlike some of these prior studies, we did not need to change the experimental procedure to achieve similar adaptation in body weight for the younger versus adult participants. For instance, Anzures and colleagues (2009) found it necessary to extend the time period of the adaptation phase for the children as compared with adults in order to see results in a facial adaptation paradigm. Here, we used the same experimental procedures in children and adults (based on a paradigm currently under research in this laboratory in adults; Boothroyd et al., 2018) and achieved similar adaptation aftereffects in both groups.

We acknowledge however, that some younger children still found our task challenging (see the 7 children excluded in Study 2 with unusable data), and our results cannot rule out that other aspects of body perception continue to emerge past 7 years of age—not least given those studies suggesting that body-selective regions of the brain are still developing into adolescence (Fontan et al., 2017). It may be that development in these regions is sufficient by 7 or 11 years of age to show adult-like performance in the current paradigms (see, e.g., evidence that some facial perception tasks show adult-like performance at younger ages than others and that adaptation effects may be evident earlier than full facial perception sensitivity; Anzures et al., 2009). We also cannot determine at what age these aftereffects first become evident. Our youngest participants were 7 years, in line with the age at which the early maturation model predicts person perception is first potentially mature. However, as noted, some children at that age found the task boring or difficult, and informal attempts to use the paradigm with younger children (e.g., 5-year-old siblings of participants in Study 2 who also wanted to "have a try" at the science day) showed that they were not able to maintain attention for the necessary period. As such, although it would be desirable that tests of adaptation also be extended to younger participants in order to verify at what age these adaptation effects can first be seen to be adult-like, attempts to locate the youngest age of body size adaptation would likely require a different testing approach.

As noted in the Introduction, the purpose of this research was not specifically to test between (single) norm-based and multichannel approaches to understanding adaptation aftereffects. Surprisingly, results were consistent with the latter in the 12-year-olds in Study 1 and with the former in all other samples (including those younger than 12 in Study 2). As discussed above, exclusion of the most emaciated bodies in Study 2 may have eliminated this effect and suggests that the changes in ratings in Study 1 were not limited to the upper end but rather simply generally applied to any non-emaciated images. Given the hint that the student sample may also have shown a slight trend in this direction in their plotted data for Study 1, this would suggest that adaptation effects can happen separately or semi-independently to different categories of bodies—as has been seen, for instance, in adaptation experiments with male versus female bodies (Brooks et al., 2019), and own versus others' bodies (Brooks et al., 2016). Alternatively, Rohrer and Arslan (2021) argued that ceiling and floor effects can produce spurious interactions. Given that the emaciated bodies are well outside typical perceptual experience (being images of women with BMIs typically seen only in, e.g., severe anorexia nervosa), a floor effect on viewing all images below a certain BMI as "very underweight" could have constrained the lower end of the ratings. Therefore, Study 2 likely represents a stronger methodology going forward.

Across the two studies, we found that larger bodies were more effective in changing perceptions than the thin stimuli despite different results regarding which weight ranges were more affected by the exposure period. Which groups of adapting stimuli (larger vs. smaller) are more effective vary across studies, with some authors (e.g., Hummel et al., 2013; Winkler & Rhodes, 2005) sometimes finding it easier to manipulate body perceptions with slim stimuli than with larger bodies, and others typically finding symmetric adaptation effects (Brooks et al., 2016, 2019; Stephen et al., 2016). It is possible that differences in stimuli may contribute to this.

A key implication of our results is that those visual processes that maintain the perceptual element of thin ideals in adult populations also likely apply to children well before puberty and that any remedial changes in our visual environment (e.g., inclusion of a more diverse sample of body weights in the media) would likely benefit these younger groups to the same degree as adults. This is also consistent with evidence that children show attitudinal thin ideal internalization from 5 or 7 years of age onward (Evans et al., 2013; Rice et al., 2016) and that viewing or playing with ultra-thin dolls may induce a desire for a slimmer body in young girls (Boothroyd et al., 2021; Dittmar et al., 2006; Jellinek et al., 2016; Rice et al., 2016).

One caveat regarding our data is that by relying on the psychology participant pool for our adult samples, we had significantly fewer male participants in this upper age bracket, and these participants may have been atypical of the general population in terms of interest in body-image-related issues, although the lack of age group differences in ratings suggests that our adult data are unlikely to differ from broader populations. We also acknowledge that all our data were gathered within a small geographical area in Northern England and strongly recommend replication with more representative international samples.

We also note that this research focused on perceptions of other people's bodies (a third-person perspective) rather than on participants' perceptions of their own bodies (a first-person perspective) or their qualitative feelings about their own bodies. Therefore, we are unable to determine whether the visual exposure in our experimental paradigm would have affected perceived size of participants' own bodies (although the evidence from one prior doll exposure study suggests that it would not; Boothroyd et al., 2021) or affective body image. Nor can we determine whether children with elevated thin-ideal internalization of body concerns at baseline would have shown stronger adaptation effects than others—although evidence for that kind of variation in adults is equivocal (e.g., Stephen et al., 2018, vs. Boothroyd et al., 2012). Further research can explore the boundaries and moderators of weight adaptation effects in children.

In conclusion, we have demonstrated that perceptions of body weight are subject to adaptation aftereffects that are adult-like from 7 years of age onward. Thus. these results have implications for our understanding of body size (mis)perception in health and well-being contexts as well as for our broader understanding of the development of body perception.

CRediT authorship contribution statement

Anjali Batish: Writing – original draft, Investigation, Data curation. **Amelia Parchment:** Investigation, Data curation. **Evan Handy:** Investigation. **Martin J Tovée:** Resources. **Lynda G Boothroyd:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

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Data availability

Full analysis output is included in the online supplementary material. Underlying data and code can be accessed on the Open Science Framework (https://osf.io/uz36w).

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jecp.2025.106203.

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