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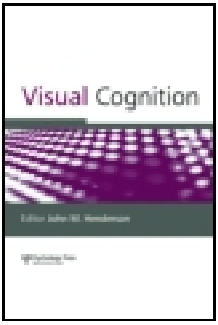

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Enhanced facial symmetry assessment in orthodontists

Tate H. Jackson[a], Kait Clark[b] & Stephen R. Mitroff[ab]

[a] Department of Orthodontics, School of Dentistry, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

[b] Department of Psychology and Neuroscience, Center for Cognitive Neuroscience, Duke University, Durham, NC, USA

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Enhanced facial symmetry assessment in orthodontists

Tate H. Jackson[1], Kait Clark[2], and Stephen R. Mitroff[1,2]

[1]Department of Orthodontics, School of Dentistry, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA
[2]Department of Psychology and Neuroscience, Center for Cognitive Neuroscience, Duke University, Durham, NC, USA

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Assessing facial symmetry is an evolutionarily important process, which suggests that individual differences in this ability should exist. As existing data are inconclusive, the current study explored whether a group trained in facial symmetry assessment, orthodontists, possessed enhanced abilities. Symmetry assessment was measured using face and nonface stimuli among orthodontic residents and two control groups: university participants with no symmetry training and airport security luggage screeners, a group previously shown to possess expert visual search skills unrelated to facial symmetry. Orthodontic residents were more accurate at assessing symmetry in both upright and inverted faces compared to both control groups, but not for nonface stimuli. These differences are not likely due to motivational biases or a speed–accuracy tradeoff—orthodontic residents were slower than the university participants but not the security screeners. Understanding such individual differences in facial symmetry assessment may inform the perception of facial attractiveness.

Please address all correspondence to Tate H. Jackson, CB #7450, 262 Brauer Hall, Department of Orthodontics, School of Dentistry, University of North Carolina, Chapel Hill, NC 27599-7450, USA. E-mail: tatejackson@unc.edu

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Keywords: Face; Symmetry; Individual differences; Perceptual processing; Orthodontics.

Symmetry is a universal biologic concept that contributes to judgements about health, mate selection, and attractiveness in numerous animal species including humans (Watson & Thornhill, 1994). More specifically, facial symmetry has been identified as a factor, independent of varying cultural norms, that determines attractiveness (Rhodes, 2006). The ability to assess facial symmetry may, therefore, have important implications for an individual's ability to select a healthy mate and ultimately improve his or her genetic fitness.

Given the potential biological impact of facial symmetry, it is not surprising that symmetry and facial perception have received broad research interest. A great deal has been learned through neuroimaging investigations, which have identified a neural network associated with face processing (Kanwisher & Yovel, 2006) as well as brain regions engaged when assessing facial symmetry in particular (Chen, Kao, & Tyler, 2007). In addition to identifying the mechanisms involved in face processing and facial symmetry assessment per se, a body of evidence has also characterized the broader abilities of humans to perceive faces in general. For example, face recognition expertise has been explored, with advantages demonstrated in healthy individuals for upright versus inverted faces (Valentine, 1988) and for own-race versus other-race faces (Mondloch et al., 2010). Similarly, research has isolated mechanisms that appear to be at play when symmetry is perceived in a face (Rhodes, Peters, Lee, Morrone, & Burr, 2005) beyond the basic visual processes involved in symmetry perception of nonface objects. Healthy individuals exhibit superior symmetry assessment for faces compared to images (Jones, Victor, & Conte, 2012), and this is true even for inverted (upside-down) faces—which match only the low-level processing characteristics of faces (Rhodes, Peters, & Ewing, 2007; Rhodes et al., 2005).

Of particular relevance for the current study, prior research has examined individual variation in facial symmetry processing with a particular focus on biological and psychological factors. For example, hormonal changes in women can affect this ability—facial symmetry assessment is better during the menses than the luteal phase of the menstrual cycle (Oinonen & Mazmanian, 2007); counter to the theory that symmetry judgement is more accurate near times of fertility (Gangestad & Thornhill, 1998), no increase in accuracy was found near the time of ovulation. Another counterintuitive finding is that individuals diagnosed with psychological disorders of perception, such as body dysmorphic disorder, do not demonstrate differences in facial symmetry assessment ability (Reese, McNally, & Wilhelm, 2010). Such results raise questions as to whether facial symmetry judgement is an ability that behaves in a predictable manner.

Considering that facial symmetry judgements are core to assessing attractiveness and mate selection, it is important to understand whether such processing functions in a predictable fashion. Moreover, it is necessary to understand whether (and how) facial symmetry abilities may differ between populations. Not only can such evidence inform the nature of facial symmetry processing, but it is also practically important from a research perspective—can the results and implications of facial symmetry research obtained with convenience samples of "laypersons" be extended to all populations? A beginning point for answering such questions is by investigating whether some individuals may possess enhanced facial symmetry processing. The current study explores this possibility by examining a particular group of participants—orthodontists.

Most people consider orthodontics a practice to correct crooked teeth, but orthodontics, in conjunction with dentofacial orthopaedics and/or orthognathic surgery, can have dramatic effects on the symmetry of the face as a whole, and orthodontists are specifically trained to assess and improve facial symmetry. One study in which participants were asked to objectively compare asymmetry between different individuals' faces suggests that orthodontists and surgeons might judge facial symmetry more accurately than other groups (Huisinga-Fischer, Souren, van der Werken, Prahl-Andersen, & van Ginkel, 2004). This study is suggestive, but leaves room for alternative explanations due to the nature of the stimuli and tasks. Specifically, it is difficult to make strong claims about differences in performance due to expertise since the faces assessed had both pathologic deviations from normal symmetry and had abnormal proportions. Participants were to rate how the faces differed in terms of deformity from normal rather than in symmetry per se, so the direct role of symmetry is not clear.

A recent study related to facial symmetry perception demonstrated dental expertise, but participants were asked to rate facial attractiveness rather than symmetry itself (Naini, Donaldson, McDonald, & Cobourne, 2012). Further, another investigation using "virtual" three-dimensional faces as stimuli suggested that orthodontists and oral surgeons may, in fact, demonstrate no meaningful advantage in judging facial symmetry relative to untrained individuals (Meyer-Marcotty, Stellzig-Eisenhauer, Bareis, Hartmann, & Kochel, 2011). This investigation used two-dimensional representations of faces captured with cone beam volume tomography, a diagnostic technique of great interest and expanding use in modern orthodontics. Participants viewed surface renderings for which individual face components such as the nose or chin had been displaced by quantifiable amounts in the horizontal or vertical dimension, and they were asked to rate the acceptability of these displacements. Since the thresholds to detect unaesthetic differences were statistically no different for layperson or professional participant groups, it is unclear if orthodontists and oral surgeons had any perceptual advantage.

A clearer understanding of facial symmetry assessment abilities, specifically whether differing performance can be anticipated in certain individuals or groups, may improve the current model of how symmetry judgement interacts with the perception of facial attractiveness. Our aim was to elucidate individual differences (i.e., differences in performance across and/or within individuals) and thereby gain insight to the nature of facial symmetry assessment by examining whether orthodontists—a group ostensibly trained to be facial symmetry experts—demonstrate enhanced abilities. To do so, we compared facial and nonfacial symmetry assessment ability in orthodontic residents trained in facial symmetry assessment to two control groups: (1) members of the Duke University community with no symmetry training and (2) Transportation Security Administration (TSA) airport security screening officers, a professional population known to have enhanced visual cognition abilities unrelated to facial symmetry judgement (Biggs, Cain, Clark, Darling, & Mitroff, 2013).

MATERIALS AND METHODS

Participants

Orthodontic participants with facial symmetry training were recruited from the Department of Orthodontics at the University of North Carolina (UNC) at Chapel Hill School of Dentistry and compensated $10/hour for their time. All were residents (*N* = 16, five female, Mean age = 30.65 years, *SD* = 2.94) in various stages of a 3-year programme (six in the first year, five in the second year, five in the third year). The programme includes formal didactic training (a total of 2 lecture hours) and practical experience in assessing facial symmetry. In the lecture setting, assessment of symmetry is taught in terms of clinical relevance, and important landmarks such as the inner and outer canthus of the eye, commissures of the lips, chin, nose, gonial angles, and ears are identified as potential landmarks to aid in symmetry judgements. The interaction of components to create an overall sense of symmetric balance is also elaborated. Practical experience comprises the majority of symmetry training for orthodontic residents. For each patient treated (80–100 patients are treated comprehensively over the course of the 3-year residency per resident) clinical and photographic assessment of face symmetry is completed initially during diagnosis and at intervals over the course of treatment. Residents spend 30–40 hours per week in the active clinical care of patients. All orthodontic participants, including the first-year residents, had received formal facial symmetry training before the time of testing.

Two groups of control participants without symmetry training, members of the Duke University community and TSA Officers, were recruited from two sources: the Duke University community and the Raleigh-Durham International Airport (RDU), respectively. Duke participants (*N* = 24, 14 female, Mean age = 21.15 years, *SD* = 1.74) were compensated with course credit or $10/hour for their participation. TSA Officers (*N* = 10, two female, Mean age = 42.33 years, *SD* = 10.20) were not directly compensated, as their data were collected during normal working hours as part of their employment.[1] Two additional participants in the TSA group had combined upright and inverted face accuracy scores that fell two standard deviations below the mean accuracy score for all participants, and their data were excluded from all analyses.

Apparatus

Data were acquired in three separate locations with identical protocols and environments: orthodontic residents at the University of North Carolina at Chapel Hill (UNC) School of Dentistry, university participants at Duke University in the Visual Cognition Laboratory, and TSA Officers in a private room at RDU. The experiment was run in dimly lit rooms at each location. UNC and Duke participants viewed the experiments on Dell Inspiron computers with 20-inch CRT monitors, and RDU participants viewed the experiments on Dell Vostro 260 computers and 23.6-inch monitors. Computer displays were adjusted such that all participants were presented with stimuli of the same physical size. Participants were seated at a viewing distance of approximately 57 cm with no head restraint. Stimuli were presented and responses were recorded using MATLAB (The MathWorks, Natick, MA) using the Psychophysics Toolbox (Version 3.0.8, Brainard, 1997; Kleiner, Brainard, & Pelli, 2007; Pelli, 1997). Questionnaire data were collected using the Qualtrics Research Suite (Qualtrics Labs, Inc., 2012).

Procedures and stimuli

All participants completed three symmetry tasks presented in a blocked design; task order was counterbalanced across all participants. Each task began with practice trials (six practice trials for Tasks 1 and 2; four practice trials for Task 3), which were identical to the experimental trials but used stimuli that did not appear during the experimental phase. The experimental segment, during which trial-by-trial accuracy and response times were recorded, immediately followed the practice trials. At the start of each trial, a fixation cross was presented for 500 ms and followed by the stimulus. Participants responded to each trial with one of two possible keys, and no feedback was provided. Immediately after response, participants were prompted to press the spacebar to begin the next trial.

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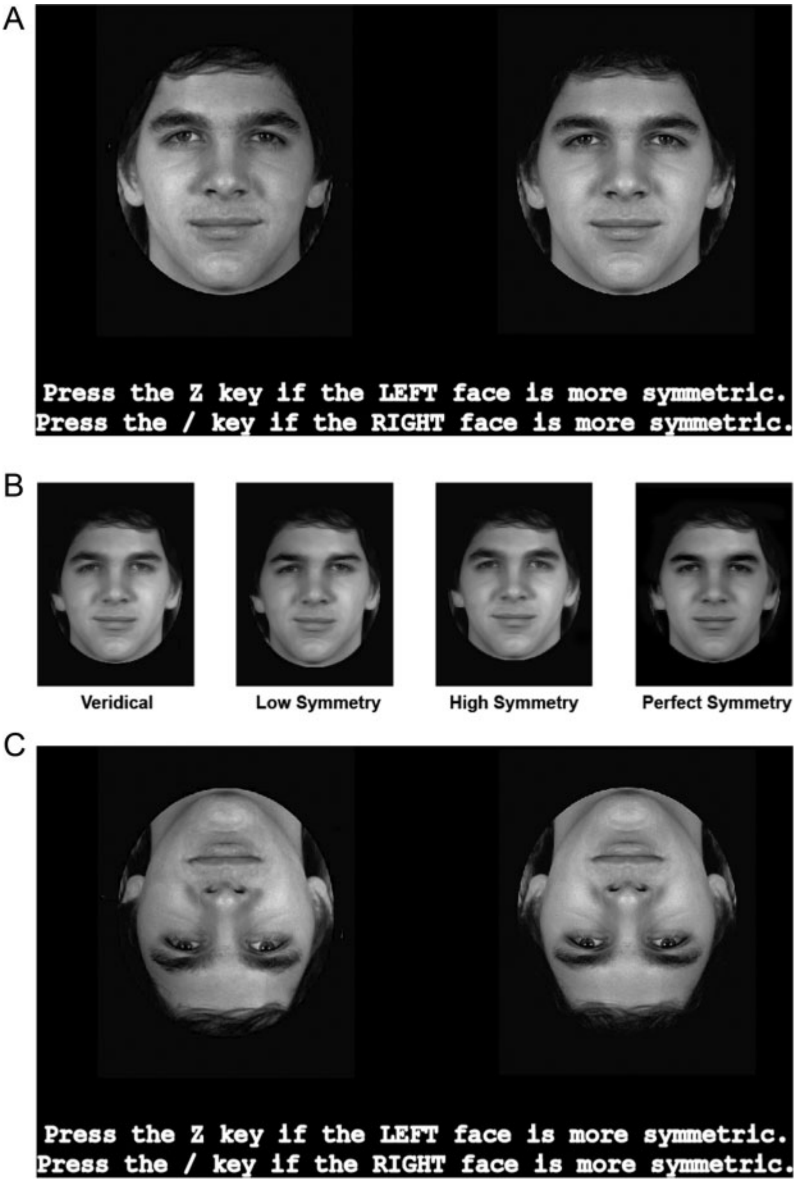
[1] The TSA Officers' participation was voluntary and confidential. See Biggs et al. (2013) for more information about the nature of their recruitment and participation in research.

Task 1: Symmetry assessment of upright faces. Participants assessed symmetry in 96 trials of upright faces by making a two-alternative forced-choice judgement between two versions of the same face, which each subtended a total area of 10.41° (horizontally) × 13.52° (vertically) of visual angle and were presented side by side (see Figure 1A). Participants were instructed to press the "z" key if the face on the left appeared more symmetric and the "/" key if the face on the right appeared more symmetric. Stimuli were presented until the participant responded. Trials were counterbalanced for each participant as to whether the face appearing on the right or left side of the screen was more symmetric. Stimuli were presented on a black background and consisted of black-and-white photographs of faces of 16 (eight female) Caucasian individuals morphed to varying levels of asymmetry while preserving averaged proportions (see Rhodes, Proffit, Grady, & Sumich, 1998, for details on stimuli generation). Note that we modified the stimuli from Rhodes et al. (1998) to use the veridical hairstyles (i.e., the hairstyle from the unaltered version of each face) for all versions. The modifications were done using Adobe® Photoshop Elements10®, and were done so that the hair could not be used as a cue to symmetry. Four versions of each face, varying in symmetry, were used: the veridical face, the face with perfect symmetry, the face with symmetry increased 50% from veridical, and the face with symmetry decreased 50% from the veridical (see Figure 1B). Six different pairings of each individual's face images were created by pairing each version with all other iterations of that face (i.e., veridical with perfect symmetry, veridical with high symmetry, veridical with low symmetry, high symmetry with perfect symmetry, high symmetry with low symmetry, and low symmetry with perfect symmetry). These stimuli were presented at random in terms of both the levels of symmetry being compared and the individual's face that was used. Participants viewed all possible pairings of each face over the course of the task.

Task 2: Symmetry assessment of inverted faces. Task 2 was identical to Task 1, except all stimuli were presented upside-down (see Figure 1C). The sequence of presentation was randomized separately from Task 1.

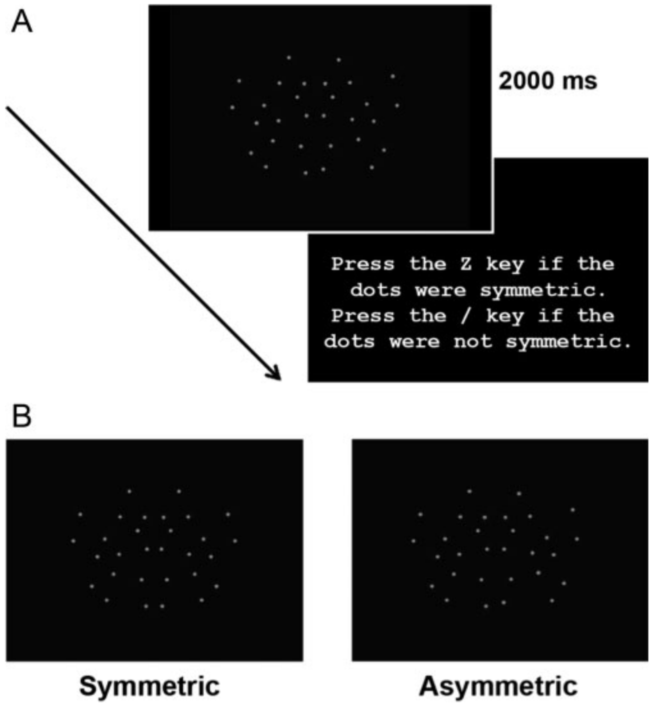
Task 3: Symmetry detection in dot patterns. Participants judged whether a pattern of yellow dots presented as a centred image on a black background was perfectly symmetric about its vertical axis (see Figure 2). Each dot image subtended a total area of 22.85° (horizontally) × 14.73° (vertically) of visual angle and was displayed for 2000 ms, after which participants were asked to provide a nonspeeded response using the "z" key to indicate that the pattern was completely symmetric and the "/" key to indicate that the pattern was not symmetric. The 2000 ms display time was used to maintain consistency with a previously used protocol designed to eliminate floor and ceiling effects for this task (Oinonen & Mazmanian, 2007). Stimuli were 18 dot patterns based on the bodies of bilaterally symmetric animals (see Evans, Wenderoth, & Cheng, 2000, for details). The nine asymmetric dot patterns were created by Evans et al. (2000)



Press the Z key if the LEFT face is more symmetric.
Press the / key if the RIGHT face is more symmetric.

Press the Z key if the LEFT face is more symmetric.
Press the / key if the RIGHT face is more symmetric.

Figure 1. (A) Example trial for Task 1. The face images were presented until response with no time limit. (B) Example face images displaying four morphed versions of one individual's face: the actual face (veridical), a version 50% less symmetric (low symmetry), a version 50% more symmetric (high symmetry), and a version with perfect symmetry. Note that the hairstyle for each version of the face is the identical, veridical hairstyle. (C) Example trial for Task 2.



Press the Z key if the dots were symmetric. Press the / key if the dots were not symmetric.

Figure 2. (A) Example trial for Task 3. Each dot pattern was presented for 2000 ms, followed by an instructions screen that remained until response. (B) Example symmetric and asymmetric dot patterns for Task 3.

using actual animal body designs with naturally occurring asymmetries, and nine symmetric versions were created by mirroring half of the original pattern for each stimulus. All 18 stimuli were presented twice in random order (once upright and once in an inverted orientation) for a total of 36 trials.

Immediately following the completion of all visual tasks, participants completed a computer-based survey with questions about demographic information, strategies employed during symmetry assessment, and subjective confidence ratings for self-assessment of performance on the tasks completed using the Royal College of Physicians Confidence Rating Scale (George et al., 2011). Confidence was rated for each task (e.g. “Please rate your confidence in assessing symmetry in an upright face.”) using this scale because it ultimately allowed responses to be dichotomized as either indicating confidence or indicating some lack of confidence. Residents were also asked how they most frequently assessed facial symmetry clinically: with the patient’s face upright or with the patient reclined and the face inverted. Duke community participants and TSA Officers were asked if they had any training or experience in symmetry assessment.

RESULTS

Performance between groups was compared using analyses of variance (ANOVAs) and Tukey's HSD for post hoc differences. Within-group comparisons between conditions were assessed with paired *t*-tests. Effect sizes and confidence intervals are reported (see Fritz, Morris, & Richler, 2011, for calculation recommendations). For two-group comparisons, effect size was assessed using a modified calculation of Cohen's *d* (Cohen, 1962) as recommended when the groups are similar in sample size but may have different standard deviations (Cohen, 1988; Keppel & Wickens, 2004). Resulting values were further adjusted to account for small sample sizes and provide a more conservative estimate of the effect size, called d_{unbiased} (Borenstein, Hedges, Higgins, & Rothstein, 2009), reported as d_{unb}. Like the standard Cohen's *d*, d_{unbiased} values of 0.8, 0.5, and 0.2 are generally representative of large, medium, and small effect sizes (Cohen, 1988). The 95% confidence intervals for effect sizes were calculated as recommended for normally distributed data (Grissom & Kim, 2005; Hedges & Olkin, 1995). For three-group comparisons, effect size is reported as ω^2 (Keppel & Wickens, 2004).

Facial symmetry performance

Between-groups differences: Accuracy and response time. Orthodontic residents' performance was compared to that of both members of the Duke community and TSA Officers using ANOVAs with group as the between-subject variable and stimulus type (upright and inverted faces separately) as a within-subject factor. Orthodontic residents were significantly more accurate than the other groups in assessing facial symmetry for both upright, $F(2, 47) = 7.84$, $p = .001$, $\omega^2 = 0.21$, and inverted, $F(2, 47) = 6.82$, $p = .003$, $\omega^2 = 0.19$, faces (see Figure 3A). There were no differences in accuracy between the Duke community participants and the TSA Officers. Response time was compared across all three groups using ANOVAs with group as the between-subject variable and stimulus type (upright and inverted faces separately) as a within-subject factor. Duke community participants spent significantly less time assessing both the upright face trials, $F(2, 47) = 16.08$, $p < .001$, $\omega^2 = 0.38$, and the inverted face trials, $F(2, 47) = 9.58$, $p < .001$, $\omega^2 = 0.26$, than the Orthodontics residents and the TSA Officers (see Figure 3B). Orthodontics residents in different years within their programme were compared using an ANOVA with year in residency as a between-subjects factor, but neither accuracy, $F(2, 15) = 0.72$, $p = .51$, $\omega^2 = 0.04$, nor response time, $F(2, 15) = 0.38$, $p = .69$, $\omega^2 = 0.08$, varied as a factor of years in residency. On the postexperiment questionnaire, no Duke community participants or TSA Officers reported training or experience in judging facial symmetry.

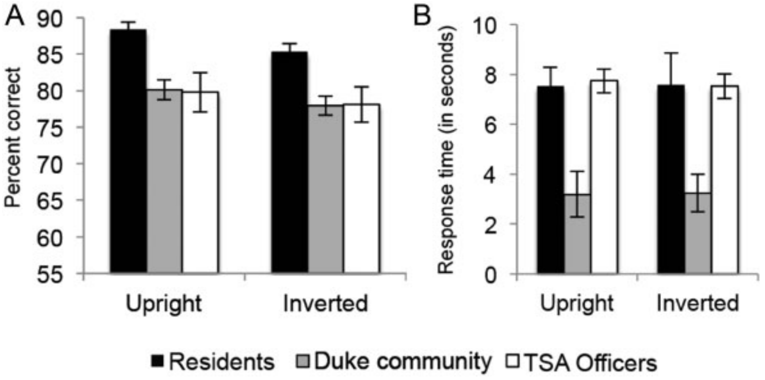


Figure 3. (A) Accuracy for each group on the facial symmetry tasks. (B) Response times for each group on the facial symmetry tasks. Error bars represent the standard error of the mean.

Accuracy by symmetry difficulty. There were four levels of symmetry (perfect symmetry, high symmetry, veridical, and low symmetry), and thus we can assess accuracy for one-step, two-step, and three-step changes in symmetry (with one-step changes being the most difficult and three-step the easiest). Using ANOVAs with group as the between-subject variable and stimulus type (upright and inverted faces separately) as a within-subject factor, residents showed an advantage in accuracy over both control groups in one-step trials for both upright, $F(2, 47) = 8.36, p = .001, \omega^2 = 0.23$, and inverted faces, $F(2, 47) = 7.94$, $p = .001, \omega^2 = 0.22$. For two-step trials, residents showed an advantage over the Duke community participants—but not TSA Officers—for upright faces, $F(2, 47) = 3.53$, $p = .038$, $\omega^2 = 0.09$. For three-step trials, there was a statistically significant difference in accuracy between residents and TSA Officers, but not Duke community participants, for upright faces, $F(2, 47) = 3.61$, $p = .035$, $\omega^2 = 0.09$. There were no statistically significant differences in accuracy for judgements of inverted faces across any groups for two- or three-step trials and no differences in accuracy across any comparisons between control groups.

Within-group accuracy differences: Upright vs. inverted faces. Orthodontics residents demonstrated an accuracy advantage upright vs. inverted faces, $t(14) = 3.28$, $p = .005$, $d_{\text{unb}} = 0.70 \pm 0.72$, but there were no differences between the upright and inverted conditions for the Duke community participants, $t(23) = 1.64$, $p = .12$, $d_{\text{unb}} = 0.26 \pm 0.57$, or the TSA Officers, $t(9) = 0.99$, $p = .35$, $d_{\text{unb}} = 0.21 \pm 0.88$. On the postexperiment questionnaire, all but two residents indicated that they assess facial symmetry when the patient is in an upright position.

Dot pattern symmetry performance

There were no significant differences in accuracy, $F(2, 47) = 0.18$, $p = .84$, $\omega^2 = 0.03$, between the groups on the dot pattern symmetry task. Response time was not a meaningful measure on this task, as the dot patterns were displayed for a set amount of time, after which participants responded. Still, there were no differences between the groups in the time taken to respond after the stimulus display, $F(2, 47) = 3.06$, $p = .056$, $\omega^2 = 0.08$.

Confidence ratings

Self-assessed confidence ratings were analysed using the data recorded from the postexperiment questionnaire, where “4” indicates full confidence in most cases, “3” indicates confidence in some cases, “2” indicates satisfactory but lacking confidence, and “1” indicates no confidence. Scores of “4” or “3” indicate confidence, whereas “2” and “1” show a lack of confidence. Residents showed the largest range of confidence scores in accuracy for the various symmetry tasks, with their highest confidence reported for upright faces and their lowest confidence for the dot patterns. Both Duke community participants and TSA Officers demonstrated a narrower range of confidence scores (see Table 1). Orthodontic residents’ confidence in their abilities better followed their performance than either the Duke community participants or the TSA Officers. For example, the orthodontics residents were significantly more accurate at assessing symmetry in the upright faces compared to detecting symmetry in the dot patterns, $t(15) = 9.96$, $p < .001$, $d_{\text{unb}} = 3.27 \pm 1.09$, and their confidence

TABLE 1
Accuracy (% correct), response time (s), and confidence scores

	Residents	*Duke participants*	*TSA officers*	*Residents vs. Duke participants*	*Residents vs. TSA officers*	*Duke participants vs. TSA officers*
Accuracy, Mean (*SD*)						
Upright faces	88.41 (3.90)	80.12 (8.52)	79.79 (6.66)	$p = .002$**	$p = .010$**	$p = .991$
Inverted faces	85.35 (4.38)	77.95 (7.66)	78.39 (6.21)	$p = .003$**	$p = .028$*	$p = .983$
Dots	64.76 (8.94)	65.97 (10.56)	63.89 (9.07)	$p = .922$	$p = .974$	$p = .839$
Response time, Mean (*SD*)						
Upright faces	7.54 (2.92)	3.19 (1.52)	7.74 (4.44)	$p < .001$**	$p = .981$	$p < .001$**
Inverted faces	7.58 (5.07)	3.24 (1.55)	7.63 (3.95)	$p = .001$**	$p = .999$	$p = .005$**
Dots	0.89 (0.49)	0.64 (0.26)	0.93 (0.46)	$p = .110$	$p = .973$	$p = .124$
Confidence, % responses indicating confidence[a]						
Upright faces	100.0	91.6	70.0			
Inverted faces	50.1	50.0	50.0			
Dots	25.0	54.2	70.0			

p-values for post hoc analysis (Tukey’s HSD). *Significant at $p < .05$, **significant at $p < .01$.
[a]Royal College of Physicians Confidence Rating Scale: 4 = fully confident in most cases, 3 = confident in some cases, 2 = satisfactory but lacking confidence, 1 = not confident (responses of 3 or 4 indicate confidence).

ratings mirrored this advantage, Wilcoxon signed-rank test $z(15) = 3.26$, $p = .001$. Alternatively, the TSA Officers, were also more accurate for the upright faces than the dot patterns, $t(9) = 3.63$, $p < .001$, $d_{\text{unb}} = 1.90 \pm 1.07$, but their confidence ratings were equivocal between these conditions, Wilcoxon signed-rank test $z(9) = 0.38$, $p = .71$.

DISCUSSION

The current study sought to inform the nature of facial symmetry processing by examining performance among three participant groups: (1) Orthodontic residents, who are facial symmetry experts; (2) Duke community participants without any special training in facial or symmetry processing; and (3) TSA Officers, professionals who demonstrate enhanced visual abilities (Biggs et al., 2013) but do not receive specific training or experience with facial symmetry. The Orthodontic residents demonstrated a clear advantage in assessing facial symmetry compared to the other participant groups, and this advantage was most pronounced for the most difficult trials and for judgements of upright faces. Importantly, by having two control comparison groups, we can diminish general concerns about the differences being driven by a speed–accuracy tradeoff or confounded participant biases (e.g., level of motivation) or group differences (e.g., age). Specifically, despite being just as relatively slow to respond as the orthodontic residents, the TSA Officers did not match their heightened accuracy on facial symmetry assessment. Instead, the TSA Officers' accuracy performance was equivalent to that of the Duke community participants who spent significantly less time judging symmetry on average.

In addition to confirming that orthodontic residents possess expertise in assessing facial symmetry, our results offer insight into the nature of this expertise as well as related implications. In particular, the residents had an advantage in assessing symmetry in inverted faces compared to both Duke community participants and TSA Officers. Since inverted faces are objects that match the low-level properties of faces but are not fully processed as such (Rhodes et al., 2004), these data suggest that residents' expertise is not limited to the higher-level mechanisms engaged in upright face processing (Rhodes et al., 2005). Moreover, the fact that the residents showed no advantage over other groups in detecting symmetry in dot patterns suggests that their expertise in facial symmetry assessment may not be generalizable to all types of symmetry processing either. Finally, the fact that the residents showed a within-group advantage for accuracy in upright versus inverted faces, and the fact that the residents' advantage over the control groups stemmed primarily from better performance with upright faces further indicates that their expertise is especially robust for upright faces. These data also support previous findings (e.g., Rhodes et al., 2007) that the inverted face effect exists for judgements of facial symmetry. Interestingly, the upright advantage aligns with the daily practices of the residents since all but two reported assessing facial symmetry with their patients in an upright position. This fact is especially significant because the majority of routine patient interaction occurs with the patient reclined and the orthodontist viewing an inverted face while administering care. Together, these two points imply that time actively spent assessing symmetry with patients upright may contribute more to facial symmetry assessment ability than simple exposure to inverted faces. It is important to point out that, in previous investigations (e.g., Rhodes et al., 2005), an advantage for upright faces has been demonstrated in layperson populations. Our study did not show the same effect, and this is likely due to a lack of sufficient statistical power.

Orthodontic residents were also better able to judge their own abilities as indicated by confidence ratings for each task that mirrored their performance (see Figure 3A and C). Neither Duke community participants nor TSA Officers showed the same ability to assess whether they had performed well or poorly. This evidence aligns well with the theory that accurate self-perception of ability is associated with expertise developed over time through training (Kruger & Dunning, 1999). Differences in confidence ratings and performance were particularly interesting when comparing the orthodontic residents and the TSA Officers. It is likely that the discrepancy stems from the TSA Officers' absence of expertise in facial symmetry tasks and an inflated confidence with the dot pattern task. TSA Officers spend time engaging in visual tasks with object rather than faces, and have been shown to have enhanced search abilities with objects (Biggs et al., 2013). Accordingly, these factors may have affected their confidence ratings for the dot pattern task.

Our data suggest that the ability to assess facial symmetry may be developed with targeted training and practice; however, longitudinal data are needed to rule out a possible self-selection account wherein individuals who possess some inherent or preexisting enhanced visual cognition skill set that improves facial symmetry judgement are more likely to become orthodontic residents. For example, research has shown that individuals who pursue dental careers, such as orthodontics, have enhanced visual abilities when it comes spatial reasoning (Hegarty, Keehner, Khooshabeh, & Montello, 2009). Nevertheless, our data suggest that some combination of preexisting aptitude and training can alter facial symmetry assessment abilities in a predictable manner. Awareness of these individual differences in the judgement of facial symmetry may ultimately allow for a better understanding of the perception of facial attractiveness. Since facial symmetry assessment appears to be subject to individual variation at some level, future research should take this factor into account when investigating facial symmetry assessment both in terms of participant selection and the generalizability of results.

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