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ORIGINAL ARTICLE

Shy Children are Less Sensitive to Some Cues to Facial Recognition

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Abstract Temperamental shyness in children is characterized by avoidance of faces and eye contact, beginning in infancy. We conducted two studies to determine whether temperamental shyness was associated with deficits in sensitivity to some cues to facial identity. In Study 1, 40 typically developing 10-year-old children made same/different judgments about pairs of faces that differed in the appearance of individual features, the shape of the external contour, or the spacing among features; their parent completed the Colorado childhood temperament inventory (CCTI). Children who scored higher on CCTI shyness made more errors than their non-shy counterparts only when discriminating faces based on the spacing of features. Differences in accuracy were not related to other scales of the CCTI. In Study 2, we showed that these differences were face-specific and cannot be attributed to differences in task difficulty. Findings suggest that shy children are less sensitive to some cues to facial recognition possibly underlying their inability to distinguish certain facial emotions in others, leading to a cascade of secondary negative effects in social behaviour.

Keywords Shyness · Faces · Face recognition · Temperament · Children

Introduction

Adults are 'experts' in face processing: they can recognize thousands of individual faces rapidly and accurately, and they can easily decipher specific cues in a single face, including emotional expression, head orientation, direction of gaze, and sound being mouthed [1, 2]. Adults' expert face recognition is related to their sensitivity to three reliable cues to a

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Journal : Small 10578 Dispatch : 8-7-2009 Pages : 14
Article No. : 150 LE TYPESET
MS Code : CP DISK

face's identity: the appearance of individual features (featural processing), the shape of the external contour (contour processing), and small differences among faces in the spacing of facial features (a kind of configural processing called second-order relational processing). To measure the development of sensitivity to each of these cues, Mondloch et al. [3, 4] developed a task in which participants make same/different judgments about pairs of faces. They modified a single Caucasian female face (Jane) to create 12 new versions (Jane's sisters). Four sisters differed from Jane in the shape of the eyes and mouth (featural set), four differed in the spacing among features (spacing set), and four differed in the shape of the external contour (contour set). Adults' accuracy was high (>75%) for all face sets, but the age at which adult-like accuracy was achieved varied. Whereas 6-year-olds were adult-like for the contour set and 10-year-olds were adult-like for the featural set (with 6-year-olds being nearly adult-like), even 14-year-olds made more errors than adults on the spacing set.

Mondloch et al. [3, 4] emphasized the age at which various skills became adult-like; however, within each age group, there were individual differences in performance. For example, the mean percent correct for 10-year-olds on the spacing set was .73 (SD = .12), but individual scores ranged from .50 to .93. The goal of the present study was to investigate one variable that may contribute to these individual differences: temperamental shyness.

Adults' expert face recognition is shaped by experience. Their expertise is limited to stimuli with which they have a wealth of experience—typically upright human faces of their own-race (see [5] for a review). They make more errors when human faces are inverted [6, 7] or of an unfamiliar race [8, 9]. The amplitude of the N170, an event-related potential that occurs approximately 170 ms after stimulus onset that appears to be face-specific, is also larger for human than for monkey faces [10] and after becoming familiar with a single monkey/human face, adults look longer at a novel human face but not a novel monkey face [11]. This perceptual narrowing begins during infancy [11–14], with several studies showing better recognition of own-race faces during childhood [15–17]. More specifically, sensitivity to features and their spacing is influenced by experience. Both 8-year-olds and adults are less sensitive to small differences in the spacing of facial features in monkey faces than in human faces, even when the metric changes are matched across the two sets [18]. Similarly, adults are less sensitive to both featural and spacing cues in other-race than in own-race faces [8, 19]. Finally, early visual deprivation associated with bilateral congenital cataract causes permanent deficits in sensitivity to the spacing of facial features [20].

The studies cited above all reported group differences in face recognition caused by differences in experience. The purpose of the present study was to examine whether individual differences in sensitivity to these three cues to facial identity were associated with natural variability in experience with faces associated with temperamental shyness. Shyness is characterized by an anxious preoccupation of the self in response to, or anticipation of, real or imagined social interaction [21]. Although there are multiple behavioural, cognitive/affective, and psychophysiological correlates associated with shyness (see [22] for a review), one highly salient feature of the phenomenon is the avoidance of face-to-face interaction and gaze aversion [23]. Surprisingly, however, there has been little empirical work devoted to examining the relation between shyness and face processing.

The literature on the topic of shyness and face processing is scant and has focused primarily on emotion perception. For example, children's shyness has been previously linked to deficits in classification of emotional facial expression [24]. In another study,

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Article No. : 150 □ LE □ TYPESET
MS Code : ☑ CP ☑ DISK

Battaglia et al. [25], using electrocortical measures, reported that children's shyness was related to smaller N400 amplitudes in response to viewing angry and neutral, but not happy, facial expressions. Children and adolescents clinically diagnosed with social phobia, an extreme variant of shyness, have also been reported to have difficulties with the accurately identifying emotional expressions [26]. Here we extend this literature by investigating the relation between shyness and sensitivity to three cues to facial identity.

To investigate this question, we conducted two studies. In Study 1, we administered the Jane task of face recognition [3] to 40 typically developing 10 year olds. We did not select children who were temperamentally shy, but divided the participants into three groups based on their score on the shyness scale of the Colorado childhood temperament inventory (CCTI). We predicted that the group of children with the highest scores would be less accurate at distinguishing faces based on one or more cues to facial identity. In Study 2, we examined whether the results found in Study 1 were specific to faces and whether they were related to task difficulty.

Study 1

Method

Participants

Forty 10-year-old children (18 males) and their parents were recruited from a Child Database maintained by the Department of Psychology, Neuroscience & Behaviour at McMaster University. The database contains the contact information of children born at hospitals in the Hamilton, Ontario region whose mothers volunteered to be contacted about research at the time of the child's birth. The children in the database are all from relatively homogenous backgrounds. All children were born healthy and full-term, were typically developing, and had normal or corrected to normal vision at the time of testing. One additional child was tested but excluded from the final sample because he failed to meet criterion on the control task (see below). All children were Caucasian and right-handed.

Stimuli

The face stimuli (Fig. 1) have been used in previous studies (see [3] for details). A single Caucasian female face (Jane) was modified to create 12 new versions ('Jane's sisters'). Four sisters (the spacing set) differed only in the spacing of features, four (the featural set) differed only in the appearance of the eyes and mouth, and four (the contour set) differed only in the shape of the external contour. Jane and three completely novel faces ('Jane's cousins') comprised the control stimuli; these faces differed on all three dimensions. All stimuli were 10.2 cm wide and 15.2 m high ($5.7° \times 9.1°$ from the testing distance of 100 cm).

Temperament Measure

The CCTI is a widely used measure to index children's temperament and has excellent psychometric properties [27, 28]. The CCTI comprises 30 items and six subscales: shyness, sociability, activity, attention span, emotionality, and soothability. Of particular interest

Journal : Small 10578 | Dispatch : 8-7-2009 | Pages : 14
Article No. : 150 | ☐ LE | ☐ TYPESET
MS Code : | ☑ CP | ☑ DISK

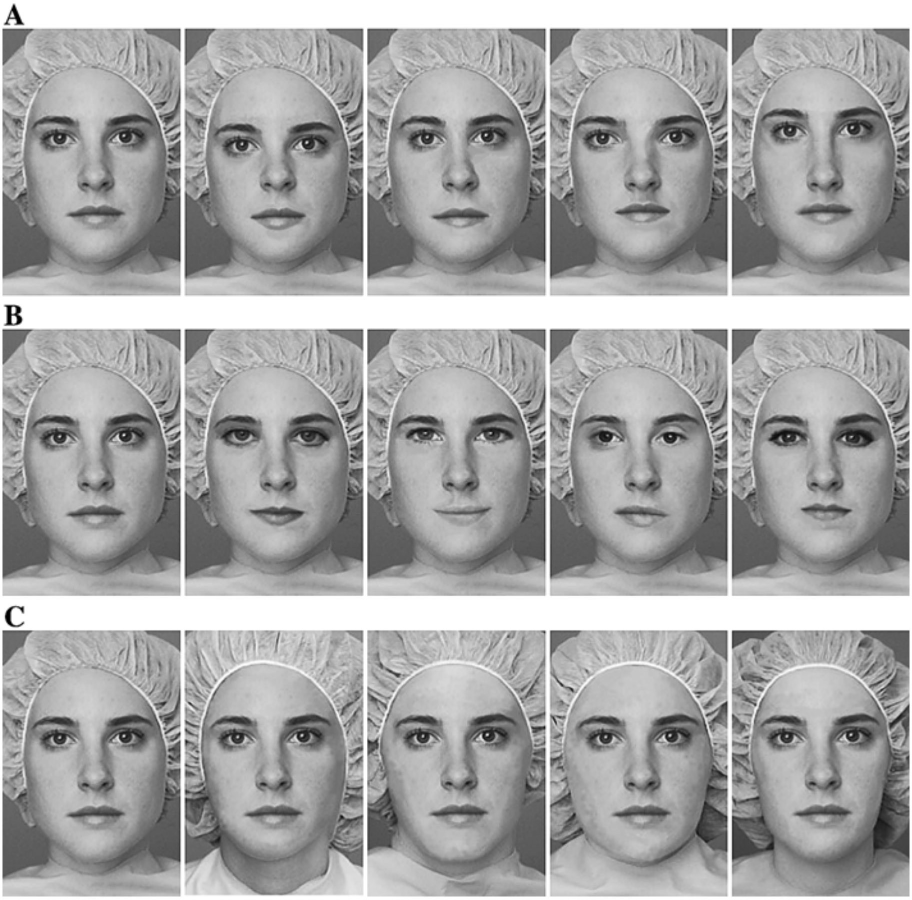

Fig. 1 Face stimuli used in Study 1. "Jane" is shown as the *left-most face* in each panel, along with her sisters from the Spacing Set (*Panel A*), the Featural Set (*Panel B*), and the external contour set (*Panel C*). Faces in the spacing set differed only in the spacing among features and covered most of the natural variation among Caucasian female faces in the real world. Reprinted with permission from *Perception*, 2002, vol 31, pp 553–566 (Pion Limited, London)

were the shyness (e.g., "Child takes a long time to warm up to strangers") and sociability (e.g., "Child likes to be with people") subscales. Sociability is known to be conceptually and empirically orthogonal to shyness [29, 30], but related to social behaviour and thus allowed us to examine the specificity of the shyness measure. Items are answered on a 5-point scale, with one representing "not at all like my child" and five representing "a lot like my child".

Procedure

All procedures were approved by the McMaster University Research Ethics Board. Upon arrival, the parent and child were briefed about the procedures and written consent was obtained. While the child was completing the face recognition task, the parent completed the CCTI. Participants sat 100 cm from a computer monitor on which the faces were

Journal : Small 10578 | Dispatch : 8-7-2009 | Pages : 14
Article No. : 150 | ☐ LE | ☐ TYPESET
MS Code : | ☑ CP | ☑ DISK

presented and signaled their responses via a macally i-shock controller. The procedure for the child began with a practice task requiring same/different judgments of two identical faces or two radically different versions of the same face (e.g., a face with eyes rotated 45° clockwise; see [3] for details). To participate in the main experiment, participants were required to be correct on at least 10 of the 12 practice trials; every child met this criterion.

On each trial of the main task, one of five possible faces appeared for 200 ms, followed by a 390 ms inter-stimulus interval and then by a second face that appeared until the participant responded "same" or "different" by pressing one of two buttons on a joystick. There were three blocks of trials ($n = 30$ trials per block); within each block, all of the faces were from the same set (e.g., featural), and the correct response was "same" for half of the trials. The order of the blocks varied across participants. After completing the experimental blocks, the child completed a control block in which they made same/different judgments about 'Jane' and her cousins. The control block ensured the participant was "playing the game" through the end of the task. The one child who did not obtain an accuracy of at least 70% on the control block was eliminated from analyses. The stimuli were presented using Cedrus Superlab 1.77 software.

Results

In order to examine the relation between individual differences in temperamental shyness and face recognition, we rank-ordered the children based on their CCTI shyness scores and created three groups of children who varied in shyness: *high shy* ($n = 11$, $M = 16$, range = 14–19); *middle shy* ($n = 15$, $M = 12$, range = 11–13); and *low shy* ($n = 14$, $M = 8$, range = 5–10). Male and female participants did not significantly differ in response across the three sets of faces (P's > .115). Consequently, all subsequent analyses were collapsed across sex. We then conducted a repeated measures analysis of variance (ANOVA) on proportion correct responses with Shy Group (high, middle, low) as the between-subject factors and Face Set (spacing, features, contour) as the within-subjects factor.

The analysis revealed a significant Shy Group × Face Set interaction, $F(4, 74) = 2.75$, $P = .034$, $\eta_p^2 = .130$. To decompose the interaction, we then conducted a separate ANOVA for each face set with Shy Group as the between-subjects factor. The analysis revealed a significant main effect for Shy Group only for accuracy on the spacing set, $F(2, 37) = 6.72$, $P = .003$, $\eta_p^2 = .266$. Planned comparisons revealed that children in the high shy group ($M = .630$, SE = .020) were significantly less accurate than children in the middle ($M = .756$, SE = .026; $P = .001$) and low ($M = .716$, SE = .023; $P = .017$) shy groups on the spacing set. The middle and low shy groups did not significantly differ on accuracy for the spacing set, $P = .210$. There were no significant main effects for Shy Group on the accuracy measure for the featural set, $F(2, 37) = 1.60$, $P = .215$, or the contour set, $F(2, 37) = .53$, $P = .594$ (see Fig. 2).

To determine whether accuracy of the high shy group was lower than that of established norms for 10-year-old children, we transformed each child's accuracy score into a z-score based on the normative sample ($n = 36$) tested by Mondloch et al. [3]. We then used 1-tailed t-tests to determine whether these standardized scores differed from zero. The high shy group was significantly less accurate than the normative sample for the spacing set [$t = -5.89$, $P < .001$], but the middle [$t = .361$, $P = .724$] and low [$t = 1.397$, $P = .184$] shy groups were not. None of the three groups differed from the normative sample for the contour set, (Ps > .16). Additionally, for the feature set, the three groups did not significantly differ from the normative sample; however, there was a trend for the high shy group being less accurate than the normative sample [$t = -1.87$, $P = .092$].

Journal : Small 10578 | Dispatch : 8-7-2009 | Pages : 14
Article No. : 150 | ☐ LE | ☐ TYPESET
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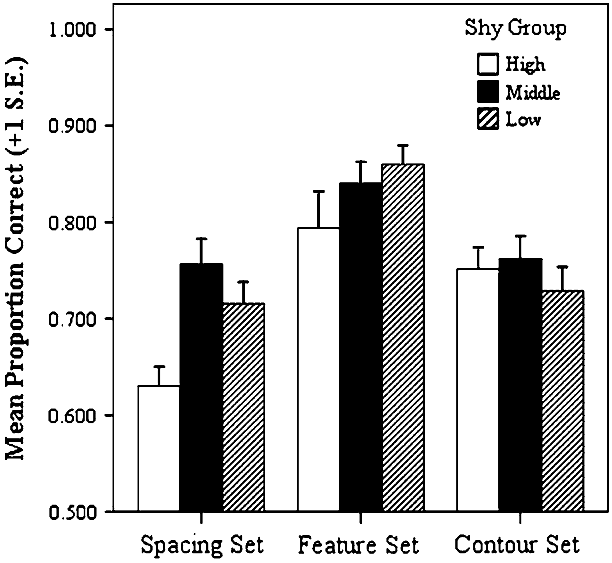

Fig. 2 Mean proportion correct (+1 SE) for each face set and each Shyness Group for Study 1

Table 1 Mean and standard deviation (SD) on the reaction time measure for the three groups by face set for Study 1

Set	Shy group					
	High		Middle		Low	
	Mean	SD	Mean	SD	Mean	SD
Spacing	1,084.41	248.13	986.25	207.66	1,094.67	300.78
Feature	1,076.41	314.64	982.50	148.13	1,072.03	232.50
Contour	1,059.36	276.61	1,046.32	205.90	1,161.40	351.58

Differences in accuracy on the spacing set cannot be attributed to speed-accuracy tradeoffs. Table 1 presents the mean and standard deviations on the reaction time measure for the three groups by face set. A 3 (Shy Group) × 3 (Face Set) ANOVA on median reaction times on correct trials revealed no significant main effects (all Ps > .05) and no significant interaction ($P > .05$).

To determine whether differences in accuracy were specific to shyness, we rank-ordered the participants based on their CCTI sociability scores and created three groups. A repeated measures ANOVA with Sociability Group (high, middle, low) as the between-subjects factor and Face Set as the within-subjects factor on proportion correct responses. This analysis revealed no significant interaction and no main effect of Sociability Group (Ps > .20); only the effect of Face Set was significant, $P < .001$.

Discussion

In summary, our results suggest that individual differences in temperamental shyness are associated with individual differences in sensitivity to one cue to facial identity: the

Journal : Small 10578 Dispatch : 8-7-2009 Pages : 14
Article No. : 150 ☐ LE ☐ TYPESET
MS Code : ☑ CP ☑ DISK

spacing among facial features. The high shy group made more errors on this block of trials than both the middle and low shy groups and the normative sample. This result is noteworthy given that children in the high shy group were not specifically selected for shyness. In contrast, individual differences in shyness were not associated with individual differences in sensitivity to two other cues to facial identity: the shape of individual features and the external contour.

There were two limitations to our results, however. First, Study 1 suggests that shy children may be less sensitive than their non-shy peers to differences among faces in the spacing of features. However, it is unknown whether their reduced sensitivity to the spacing among features is face-specific. Second, accuracy on the featural set was higher ($M = .86$ for 10-year-olds in a normative sample [3]) than accuracy on either the spacing ($M = .75$) or the contour ($M = .77$) sets. An alternative hypothesis, then, is that shy children made more errors on the spacing task because it was more difficult, rather than because faces differed in the spacing of features per se. Difficulty cannot offer a complete account of our previous findings because 10-year-old children's accuracy on the contour set was comparable to their accuracy on the spacing set and yet shyness was not associated with differences in accuracy for the contour set. Nonetheless, it is possible that task difficulty partially accounts for our findings. We addressed each of these concerns in Study 2 with two new tasks.

Study 2

Because shyness is associated with the avoidance of face-to-face interaction and gaze aversion [23], but not the avoidance of non-social objects and scenes, it is important to determine whether shy children perform like their non-shy peers when discriminating non-face stimuli that differ in the spacing of features. Thus, in Study 2, we tested a new group of children on their ability to discriminate houses that differed only in feature spacing. If the effects of shyness are face-specific, then shyness should not be associated with differences in accuracy for these control stimuli. Two previous studies have been conducted with these house stimuli. One showed that 8-year-olds were worse than adults when discriminating houses that differed in spacing but not when discriminating houses that differ in features, even when adult accuracy was equated for the two sets [31], a pattern like that observed for faces [3]. The other showed that patients deprived of early visual input caused by congenital cataract performed normally when discriminating both sets of house stimuli [32]. This result is in contrast to previous studies showing that these same patients have deficits in discriminating faces that differ in the spacing of features, but not the shape of features [20, 33].

The houses task also allows us to address the issue of task difficulty. Adults' accuracy on the houses spacing task is slightly lower ($M = .75$) than their accuracy on the Jane spacing task ($M = .82$; [3]) and much lower than their accuracy on the houses featural set ($M = .98$; [31]). Thus, if task difficulty underlies the relatively poor performance of shy children, they should show a similar pattern of deficits for the houses spacing task. A second approach to baseline differences in accuracy across face sets is to increase spacing changes until accuracy for the spacing set matches that for the featural set [34–37]. Although this solves the problem of unequal task difficulty, it may create another. The spacing stimuli used in the Jane task were carefully constructed to cover most of the natural variation among a representative sample of adult Caucasian faces reported by [38]. Larger changes in the spacing of features may make faces look distorted and unnatural (see [39]

Journal : Small 10578 Dispatch : 8-7-2009 Pages : 14
Article No. : 150 □ LE □ TYPESET
MS Code : ☑ CP ☑ DISK

for a complete discussion). Because the metric changes made to the faces in the spacing set used in our study cover most of the variation among Caucasian faces [38], it is unlikely that our spacing set underestimates the ability of children to use this cue in the real world. Therefore, we did not create a new set of face stimuli with larger differences in the spacing of facial features. A third approach would be to increase the difficulty of featural discriminations to determine whether shy children perform worse than their non-shy peers when featural discriminations are difficult. It is possible that we had inadvertently selected features that were especially easy to discriminate in Study 1. Because our interest lies in the relation between shyness and face recognition in the real world, we did not create especially difficult feature discriminations, but took an intermediate approach. We tested the new group of children on an enlarged featural set comprised of 20 different features (eyes and mouth). Our goal here was to determine whether shy children would perform like their non-shy peers when tested with a large number of examples that should, therefore, represent a range of difficulties. One previous study that used this enlarged feature task reported that adults' accuracy remains high, that patients treated for congenital cataract perform normally, and that 10-year-old children are close to, but not quite at, adult levels of accuracy [39]. If shy children perform like their non-shy peers for this expanded featural set, we can conclude that they are able to use this cue to facial identity in the real world. Likewise, if they perform like their non-shy peers on the difficult houses spacing task, we can conclude that their poor performance on the faces spacing task cannot be attributed to task difficulty.

Method

Participants

Another group of 29 (17 males) typically developing 10-year-old children and their parents were recruited from the same Child Database used in Study 1. Participants were classified into three groups based on their CCTI shyness score: high shy ($n = 10$, score of 13 or higher), middle shy ($n = 9$, scores of 10–12), and low shy ($n = 10$, scores of 9 or under). All children were Caucasian, right-handed, and had normal or corrected to normal vision at the time of testing. Two of the children were excluded from the expanded features task and one of the children from the house task because of technical problems.

Stimuli

House Stimuli The house stimuli were developed and used as part of another study [31]. A greyscale picture of a single house was modified to create nine new versions that differed in the spacing (positions) of the windows and door (see Fig. 3). Houses were 12 cm wide by 18 cm hight. At the 50 cm viewing distance, this corresponds to a visual angle of 13.7° by 20.4°. The 10 images were split into two groups of five. Each image from Group 1 was paired with every image of Group 2 (e.g., image 1 of Group 1 was paired with all five images of Group 2).

Expanded Featural Jane Task A single greyscale Caucasian face (Jane) was modified in order to create 19 new versions. Each version had a different pair of eyes (but the same eyebrows) and a different mouth. The horizontal length of the features was matched so as to minimize any changes in the spacing among features. All other facial characteristics

Journal : Small 10578 | Dispatch : 8-7-2009 | Pages : 14
Article No. : 150 | ☐ LE | ☐ TYPESET
MS Code : | ☑ CP | ☑ DISK

Fig. 3 House stimuli used in Study 2. Houses differed only in the spacing of features (i.e., the location of the windows and the door)

were identical. The stimuli were the same size as those used in Study 1 and included that original set of five faces.

Procedure

All participants completed the houses task followed by the expanded featural Jane task. Throughout both tasks participants sat in a dimly lit room. For the houses task, they were told that they would see a single house flash quickly (200 ms) on the center of the screen, followed by a pair of houses that remained on the screen until the participant indicated which of the two houses matched the original. Participants made their response by pressing one of two keys on the keyboard (F = left, J = right). In total, there were 50 trials presented in a different random order to each participant. The matching house was on the left side on half of the trials.

The expanded featural Jane task followed the same protocol as that described in Study 1. There were 120 trials; the correct response was ‘different’ on 60 trials. Each face was presented first on three ‘same’ trials and was presented first on three ‘different’ trials during each of which it was paired with a different face.

Results

Univariate ANOVAs were used to test for group differences in accuracy and reaction time on the house spacing task and expanded features task. We found no statistical difference among the three groups on either measure for the house spacing task (accuracy, $F(2, 25) = .25$, $P = .784$; reaction time, $F(2, 25) = .406$, $P = .671$). Accuracy on the houses task was low for all three groups of children (low shy: $M = 72.20$, SE = 3.44; middle shy: $M = 69.33$, SE = 3.09; high shy: $M = 68.89$, SE = 4.44). Similarly, accuracy on the expanded feature task did not vary across the three groups of children, $F(2, 24) = 2.59$,

Journal : Small 10578 | Dispatch : 8-7-2009 | Pages : 14
Article No. : 150 | LE | TYPESET
MS Code : | CP | DISK

$P > .05$. Accuracy was at or above .80 for all groups (low shy: $M = .88$, SE = .02; middle shy: $M = .80$, SE = .03; high shy: $M = .86$, SE = .02).

Discussion

Collectively, the results of Study 2 lead to two conclusions. First, the deficits seen in shy children when discriminating faces that differ in the spacing of features in Study 1 appear to be face-specific. Shy children performed like their non-shy peers when tested with houses that differed in the spacing of features. Second, the finding of a deficit for the spacing of facial features is unlikely attributable to task difficulty. The houses spacing task was at least as difficult as the faces spacing task, but shy children only showed a deficit for faces. That shy children perform as well as than their non-shy peers when discriminating faces that differ in the shape of individual features (eyes and mouth) is confirmed by our finding of no group differences on the expanded feature set. Of course, it still is possible that they would show deficits for especially difficult features, but they appear to be as capable as their non-shy peers when discriminating a representative sample of facial features.

General Discussion

We found that children who were shy were less accurate than their non-shy counterparts only when discriminating faces based on the spacing of features. These findings were specific to faces and the shyness temperament and were not related to task difficulty. It is also notable that shyness was associated with poorer performance on a face recognition task in our study despite our not selecting a group of children who Kagan et al. [40–44] would classify as being temperamentally shy based on their being in the top 10–15% of the population; had we selected such children, we anticipate that deficits in performance would have been equal or greater. Childhood shyness has been linked to deficits in classification of emotional facial expression [24–26], but the current study appears to be the first to link children's shyness to deficits in sensitivity to cues to facial identity.

Previous research has shown that shy children [45] and adults [46] experience task anxiety during difficult tasks (e.g., Stroop Color-Word test). Consequently, it may be argued that our findings simply indicate that the spacing set was more difficult and anxiety producing for the shy children than the feature and contour sets. However, there are two reasons why this was probably not the case. First, accuracy on both the faces contour task (Study 1) and the houses spacing task (Study 2) was comparable to that on the faces spacing task (Study 1). If difficult tasks elicit high anxiety in shy children, then the high shy group should have made more errors on all three tasks, not just the faces spacing task. Second, the shy children did not take longer to respond than their non-shy counterparts, suggesting that the experience of anxiety did not interfere and that shy children were unaware of their deficits. Thus, it is unlikely that anxiety and task difficulty systematically influenced performance in children who were shy.

This research leaves open the question as to the time course over which shyness impacts sensitivity to differences among faces in the spacing of features. Longitudinal studies have shown that inhibited infants (i.e., infants who react negatively to novelty, including unfamiliar people) often become shy children (see [40, 41], for a review). These children display a distinct pattern of psychophysiological activity at rest and in response to social

Journal : Small 10578 Dispatch : 8-7-2009 Pages : 14
Article No. : 150 LE TYPESET
MS Code : CP DISK

challenge, avoidance social situations and face-to-face interactions, and are at risk for social withdrawal and socioemotional problems (see [22, 47], for a review). One possible explanation for our findings, then, is that shy children received a different experience with faces during the first few weeks and months of post-natal life. This explanation is consistent with previous work that has shown that there is a sensitive period for the development of sensitivity to the spacing of facial features during early infancy: visual deprivation caused by congenital cataract causes permanent impairments in sensitivity to the spacing among facial features, but not the shape of individual features [20, 33]. Alternatively, the deficits we observed in shy children may be related to their ongoing avoidance of unfamiliar people and novel faces during childhood [22].

Our findings are consistent with either of these two alternatives. If the sensitive period for spacing of features is limited to the first few months of post-natal life, the deficit is perhaps related to the avoidance of novel faces during infancy and, like the cataract patients who show permanent deficits, temperamentally shy children may not 'catch up' with their non-shy peers. Conversely, if the impairments we detected are related to ongoing experience, then temperamentally shy individuals may achieve normal sensitivity to second-order relations by adulthood, albeit more slowly than non-shy individuals.

Sensitivity to differences among faces in the spacing of features underlies expert face recognition. Ten-year-old children as well as patients treated for bilateral congenital cataract make more errors than visually normal adults when making same/different judgments about pairs of faces that differ only in the spacing of features [3, 20]. In addition, both 10-year-old children and patients treated for congenital cataract make more errors than visually normal adults when performing a task that requires them to recognize the identity of an individual face when that face is shown from a novel point of view [48, 49]. Recognizing a face from a novel point of view likely requires sensitivity to the spacing of facial features because the appearance of individual features changes when the head is tilted/rotated.

Our results suggest that temperamentally shy children may have difficulty recognizing faces when seen from a novel point of view as well as under other conditions that make the appearance of individual features less reliable cues (e.g., under poor lighting conditions). Future studies should expand the current study in two ways. First, eye-tracking measures should be used to determine whether scanning patterns differ between shy and non-shy children. Second, measures of face recognition should be included to determine the extent to which individual differences in sensitivity to differences among faces in the spacing of features are related to individual differences in face recognition.

Limitations

The present study had several limitations. First, the results were based on a relatively small sample size and need to be replicated with a larger sample controlling for potential demographic influences (e.g., socioeconomic status) in order to ensure the reliability of the present findings. Second, we tested only a single cross-section of children at age 10 years. We do not know whether the effects for shy children on the face recognition task would be evidenced at younger or older ages. Accordingly, future studies involving longitudinal designs would shed light on this issue. Third, the face and house stimuli used only included one face and one house that were manipulated. In the real world, children are exposed to many different faces and objects so the extent to which the findings generalize to other faces and objects needs to be tested.

Summary

Temperamental shyness in children is characterized by avoidance of faces and eye contact, beginning in infancy. To determine whether shyness is associated with deficits in sensitivity to one or more cues to facial identity, we asked 40 typically developing 10-year-old children to make same/different judgment about pairs of faces that differed in one of three ways: the shape of individual features (the featural set), the spacing among features (the spacing set) or the shape of the external contour (the contour set). Children who scored high on the shyness scale of the CCTI, a survey completed by their parent during the lab visit, made more errors than children who scored either medium or low for only one of the three face sets—the spacing set. To determine whether their deficit in sensitivity to the spacing of features was face-specific, in Study 2 we tested a new group of children on a comparable task with house stimuli. Children who scored high on the shyness scale did not make more errors than their non-shy peers when houses differed in the spacing of features (i.e., windows and doors). To determine whether the relation between shyness and accuracy observed in Study 1 could be attributed to the spacing set being harder to discriminate than the feature set (though not the contour set), in Study 2, we tested the new group of children on an expanded feature task in which they made same/different judgments for 120 face pairs based on 20 faces that differed only in the spacing of features. Children scoring high on shyness did not make more errors than their non-shy peers on this expanded features task despite it including a range of difficulty and a more representative set of features. Differences in accuracy were not related to the sociability scale of the CCTI, indicating that accuracy on the spacing set may vary specifically with shyness. We speculate that these deficits may arise from some shy children having different experiences with faces during early development than their non-shy peers. These small differences in sensitivity to differences among faces in the spacing of features may arise from, or play some role in setting in motion the cascade of secondary negative effects associated with social problems observed in temperamentally shy children, including difficulties with understanding emotional facial expressions.

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Journal : Small 10578 Dispatch : 8-7-2009 Pages : 14
Article No. : 150 LE TYPESET
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