

Perceiving Facial and Vocal Expressions of Emotion in Individuals With Williams Syndrome

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Abstract

People with Williams syndrome are extremely sociable, empathic, and expressive in communication. Some researchers suggest they may be especially sensitive to perceiving emotional expressions. We administered the Faces and Paralanguage subtests of the Diagnostic Analysis of Nonverbal Accuracy Scale (DANVA2), a standardized measure of emotion recognition for basic emotions to three groups: adolescents and adults with Williams syndrome, age and IQ-matched participants with learning/intellectual disability, and age-matched nonimpaired controls. The Williams syndrome and learning/intellectual disability groups performed significantly worse than the typically developing controls on both subtests, especially on negative emotions. Error analysis indicated the same general pattern of performance across versions and subtests of the DANVA2 for all groups. These findings suggest that emotion recognition is not spared in Williams syndrome.

A keen interest in people, sociability and empathic concern, coupled with an affectionate, friendly personality (Doyle, Bellugi, Korenberg, & Graham, 2004; Gosch & Pankau, 1994; Mervis & Klein-Tasman, 2000; Udwin & Yule, 1991) are some of the striking features of the phenotype associated with Williams syndrome, a neurodevelopmental disorder caused by a hemizygous deletion of approximately 1.6 megabases on chromosome 7q11.23. Although certain aspects of the Williams syndrome behavioral profile, particularly the capacity for empathy, might suggest a special sensitivity to the emotional states of others, little

is known about the social-perceptual abilities of people with Williams syndrome for recognizing facial and vocal emotional expressions.

Facial expressions, gestures, body postures, and the prosodic aspects of speech are powerful nonverbal channels for conveying social meaning. A large body of research has demonstrated that deficiencies in expressive or in receptive nonverbal capacities, or the inability to integrate information conveyed through nonverbal cues with that from verbal sources, may hinder social interaction and communication (Gray, Fraser, & Leudar, 1983).

People with Williams syndrome have a strong drive toward social engagement and are proficient at deploying expressive means to maintain an ongoing interpersonal interaction (Jones et al., 2000). They show great interest in people's faces and have relatively good skills in discriminating and recognizing facial identity. On standardized tests such as the Benton Test of Facial Recognition (Benton, Hamsher, Varney, & Spreen, 1983), they usually score within the typical range of performance for age (Bellugi, Wang, & Jernigan, 1994; Wang, Doherty, Rourke, & Bellugi, 1995), despite severe deficits in visuospatial abilities. Based on these behavioral characteristics, researchers have predicted that social-cognitive capacities more generally may be spared in this population (Karmiloff-Smith, Klima, Bellugi, Grant, & Baron-Cohen, 1995). However, this hypothesis has been refuted by experimental investigations of theory of mind or social-understanding abilities in children and adolescents with Williams syndrome (Sullivan & Tager-Flusberg, 1999; Tager-Flusberg & Sullivan, 2000). Across a variety of experimental tasks tapping basic and higher order theory of mind skills, children and adolescents with Williams syndrome performed no better than did matched groups with other etiologies of mental retardation and were significantly impaired in comparison to typically developing individuals.

Possible deficits or biases in processing the social and psychological significance of facial displays by adults with Williams syndrome were reported by Bellugi, Adolphs, Cassady, and Chiles (1999), using an approachability/trustworthiness task: Participants with Williams syndrome consistently rated various faces as more approachable and more trustworthy than did chronological age (CA) and mental age (MA) matched controls. This tendency is consistent with anecdotal reports about the indiscriminant trust and friendliness of people with Williams syndrome toward strangers. Tager-Flusberg and Sullivan (2000) found that young children with Williams syndrome performed no better than age- and IQ-matched children with mental retardation in discriminating or matching facial expressions of emotion. Gagliardi et al. (2003), using an animated facial expression comprehension test (AFFECT) based on Ekman and Friesen's (1976) standardized set of expressive faces, found that children and adults with Williams syndrome performed worse than a group matched on CA of typically developing individuals but were indistinguishable from younger,

MA-matched typically developing controls. There was no discernable positive labeling bias in the interpretation of facial expressions by the participants with Williams syndrome, contrary to the authors' expectations based on the personality profile and social judgment biases found in other studies with people who have Williams syndrome (Bellugi et al., 1999). As in other studies, the Williams syndrome group performed within age norms on the Benton Test of Facial Recognition. The authors claimed that the participants with Williams syndrome used processing strategies that were different from those used by controls in recognizing facial expressions, although their study does not provide any evidence regarding the mechanisms that underlie emotion recognition in Williams syndrome. In summary, results of studies thus far suggest that face recognition is relatively spared, whereas recognition of facial expressions of emotion may be more impaired than recognition of facial identity in individuals with Williams syndrome.

Even less is known about the perception and interpretation of vocal expressions of emotion in people with Williams syndrome. Many of them show atypical reactions to sound, hyperacusis, and musical interests; and they can easily emulate singers and songs that they enjoy (Don, Schellenberg, & Rourke, 1999; Lenhoff, 1998; Van Borsel, Curfs, & Fryns, 1997). However, it is not known how these aspects of acoustic processing may relate to interpreting vocal cues in social interaction. To our knowledge there have been no studies in which researchers have examined how individuals with Williams syndrome decode vocal expressions of emotion outside a musical context.

Our main goal in this study was to examine the nonverbal receptive abilities of a large sample of adolescents and adults with Williams syndrome, using a standardized instrument designed to assess individual differences in sensitivity to facial and vocal expressions of basic emotions. The Diagnostic Analysis of Nonverbal Accuracy-DANVA2 (Nowicki & Duke, 1994) is comprised of four subtests, two for each expressive modality, namely, faces and voices. The Child Faces and Adult Faces subtests measure accuracy in decoding facial expressions of emotion displayed by children and by young adults and include multi-ethnic posers of emotion. The Child Paralanguage and Adult Paralanguage subtests assess the ability to identify emotions in the tone of voice of child and adult speakers who utter the same content-

neutral sentence. Stimuli are judged for expressing one of four emotions: happy, sad, angry, fearful. All subtests include two levels of emotional intensity (high and low). The use of this instrument enables a direct comparison of emotion recognition in two modalities of expression, faces and voices, as well as a comparison between accuracy in recognizing emotions when expressed by children versus adults. Responses can be scored quantitatively as correct/incorrect, yielding accuracy scores by subtest and by emotion, as well as qualitatively, tabulating the type of confusions for the incorrect responses (e.g., "happy" response for an angry item).

In studies using the DANVA2, researchers have found that people are generally more accurate in interpreting (a) facial expressions of emotion compared to vocal prosody and (b) the child compared to the adult version of the test. These findings have been reported for typically developing individuals (Nowicki & Carton, 1993; Nowicki & Duke, 2001), children and adults with learning disabilities (Cadesky, Mota, & Schachar, 2000; Petti, Voelker, Shore, & Hayman-Abello, 2003; Spell & Frank, 2000), and children and adolescents with behavioral problems (Blair & Coles, 2000; Stevens, Charman, & Blair, 2001). In our study we investigated whether these patterns would also be found in the Williams syndrome population. Because the ability to recognize and interpret expressions of emotion and other nonverbal social cues may be influenced by one's experience in the social world, we chose two comparison groups: one of age-, IQ-, and language-matched adolescents and adults with learning or intellectual disability, and the other, of typically developing individuals matched on CA with the clinical groups to ensure that any group differences found would not stem directly from differences in social experience related to CA.

This study is the first in which emotion labeling across modalities of expression (facial, vocal) in a large sample of individuals with Williams syndrome was examined. Recognition of facial expressions of emotion has been previously examined in two studies with individuals who have Williams syndrome, both using a set of faces from Ekman and Friesen's series (1976), either in an animated version (Gagliardi et al., 2003) or in a matching task (Tager-Flusberg & Sullivan, 2000). We have employed a different, recently developed, standardized instrument and have tested emotion labeling while controlling for facial iden-

tity recognition ability. Based on earlier findings, we predicted that the Williams syndrome group would show impairments in emotion labeling relative to the typically developing controls and comparable to the deficits found in the CA- and MA-matched group with learning or intellectual disability, despite their remarkable empathic behavior and hypersociability characteristics.

Method

Participants

Three groups of participants were included: 47 individuals with Williams syndrome (28 females), 49 with learning or intellectual disability (29 females), and 58 typically developing individuals (38 females). The participants were all between the ages of 12.08 and 32.33 years. The participants with Williams syndrome were recruited through the Williams Syndrome Association, and all had their diagnosis confirmed by a clinical geneticist and the FISH test. The majority of them (42 individuals) were tested in our laboratory, and 5 participants were tested during the 9th International Conference of the Williams Syndrome Association.

The participants with learning/intellectual disabilities were recruited through a residential school serving this population and included a mixed-etiology sample consisting of 11 with learning disabilities; 12 with language-based learning problems (dyslexia, speech, or language problems); 3 with nonverbal learning disabilities; 1 with attention deficit disorder; 1 with obsessive-compulsive disorder; 3 with low IQ or developmental delay; 1 with mitochondrial disease; 3 with chromosome abnormalities; 5 with Down syndrome; 1 with Turner syndrome; 1 with neurofibromatosis; and 7 with no documented diagnosis. Individuals with an autistic profile on the parent-report Social Responsiveness Scale (Constantino, 2004) were not included in this sample. They were all tested in a quiet room in their residential facility.

The group of typically developing individuals, recruited from local schools and universities, was matched on CA with the clinical samples and included individuals with IQs in the average range. These participants were tested in a quiet room in their schools/universities or in our laboratory.

Table 1 presents details of the participant groups, including ethnic composition of the groups and scores on standardized measures of

Table 1. Participant Characteristics by Group

Characteristic	Williams syndrome (<i>n</i> = 47)			Learning disability (<i>n</i> = 49)			Typical controls (<i>n</i> = 58)		
	Mean/ %	SD	Range	Mean/ %	SD	Range	Mean/ %	SD	Range
CA	19.49	6.4	12.1–32.4	17.88	2.4	13.5–23.1	18.19	5.3	12.1–31.8
K-BIT ^a									
Full Scale IQ	69.08	12.2	51–100	70.63	11.7	52–93	104.15	7.4	89–114
Verbal IQ	75.83	11.3	41–102	77.16	8.6	55–94	103.53	11.2	70–124
Nonverbal IQ	68.02	14.3	40–98	68.49	16.5	41–110	104.53	7.7	86–119
Vocabulary PPVT-III	79.92	9.4	62–103	82.43	10.6	54–101	108.64	10.5	87–126
Benton Facial Recognition ^b	21.59 ^c	2.6	16–27	18.44 ^d	3.1	11–27	22.74 ^e	1.8	19–26
Ethnicity (%)									
European									
American	89	—	—	86	—	—	47	—	—
African American	2	—	—	0	—	—	17	—	—
Hispanic	2	—	—	0	—	—	17	—	—
Mixed/unreported ^c	7	—	—	14	—	—	19	—	—

^aKaufman Brief Intelligence Test. ^bWilliams and learning disability groups were significantly different, $p < .01$. ^cBased on $n = 47$. ^dBased on $n = 38$. ^eBased on $n = 57$.

cognitive functioning, language, and facial identity recognition.

Measures and Procedure

All participants received the Kaufman Brief Intelligence Test–K-BIT (Kaufman & Kaufman, 1990) and the Peabody Picture Vocabulary Test–III–PPVT-III (Dunn & Dunn, 1997) to assess IQ and verbal knowledge. A test of facial discrimination was also administered: the short form of the Benton Test of Facial Recognition, which involves recognition of facial identity under different viewpoints and lighting conditions. The participants with Williams syndrome were matched on CA and PPVT standard scores to the learning/intellectual disabilities group. However, on the Benton test, the Williams syndrome group performed in the range of the typically developing group and significantly better than the learning/intellectual disabilities group, $t(82) = 5.17$, $p < .001$.

The computerized version of the DANVA2 test (Nowicki & Duke, 1994), purchased from Dyssemia Inc., was administered to each participant individually in a quiet room. The four subtests (Child Faces, Adult Faces, Child Voices,

Adult Voices) were administered in this fixed order, as instructed in the DANVA standardization manual. In the Faces subtests, the four emotion labels, *happy*, *angry*, *sad*, *fearful*, appeared on the screen below the face image. The typically developing participants used the computer mouse to select the emotion label, whereas the Williams syndrome and learning/intellectual disabilities groups gave verbal responses because our pilot testing revealed that they were more comfortable with this response modality. In the Paralanguage subtests, the auditory stimuli were presented by computer (via external speakers), with a 4-second delay between response and the next stimulus presentation. During the stimulus presentation and the 4 seconds after stimulus offset, the four emotion labels were displayed on the screen, and responses were given as described above. All responses were directly recorded by computer. The administration of the DANVA2 lasted about 20 minutes.

Results

Results are presented in three sections corresponding to the following sets of analyses: (a)

quantitative analyses of emotion recognition accuracy, (b) qualitative analyses of patterns of confusion between emotional expressions, and (c) relations between DANVA2 scores and measures of cognitive functioning.

Emotion Recognition Accuracy

Overall accuracy (percentage correct) by version and presentation modality. Preliminary analyses of percentage correct scores on the DANVA2 as a function of participant gender and age group (adolescent, 12 to 18 years of age; and adult, 19 years and older), revealed no significant differences. An additional ANOVA with ethnicity as between-subjects factor yielded no significant differences in overall accuracy on the DANVA2. Therefore, gender, age group, and ethnicity were not entered as independent variables in subsequent analyses.

Table 2 presents the mean percentage overall accuracy as a function of test version and presentation modality. Percentage correct emotion recognition responses were examined with a 3 (group: Williams syndrome, learning/intellectual disabilities, typically developing individuals) $\times$ 2 (test version: child, adult) $\times$ 2 (presentation modality: facial, vocal) mixed ANCOVA, using scores on the Benton Test of Facial Recognition as covariate, to control for differences in facial identity recognition abilities. The ANCOVA yielded significant main effects for group, $F(2, 137) = 38.03, p < .0001$, and modality, $F(1, 137) = 6.62, p < .02$, qualified by a Group $\times$ Modality interaction, $F(2, 137) = 4.07, p < .02$. Bonferroni corrected pairwise comparisons revealed that the typically developing group was significantly more accurate overall than the Williams syndrome or the learning/intellectual disabilities group, after adjusting for Benton test scores ($M = 80.78\%$ vs.

68.09% and 70.65%, respectively, $ps < .001$ for both comparisons), whereas the two latter groups did not differ from each other in overall emotion recognition accuracy. All three groups were more accurate in identifying emotions in the facial modality compared to the vocal presentation and in the child version subtests compared to the adult version. Because there were no significant interactions between group and test version or between test version, modality, and group, and no significant main effect of test version, we collapsed accuracy scores over the child and adult versions for each DANVA2 modality (Faces, Paralanguage) in subsequent analyses.

We conducted follow-up tests to evaluate pairwise differences among the adjusted means for each expressive modality separately, using the Bonferroni correction procedure to control for type I error across multiple comparisons. The typically developing group was significantly more accurate than the two clinical groups when identifying emotions in faces (85.34% correct vs. 75.34% for the Williams syndrome group and 74.75% for the learning/intellectual disabilities group, respectively) as well as when identifying emotions in voices (76.21% for typically developing individuals, 60.84% for Williams syndrome, and 66.53% for learning/intellectual disabilities). After controlling for Benton scores, we found that the Williams syndrome and the learning/intellectual disabilities groups did not differ in recognizing emotions in faces, but the Williams syndrome group was less accurate than the learning/intellectual disabilities group in recognizing vocal expressions of emotion (60.84% vs. 66.53%, respectively, $p = .05$).

Recognition accuracy (percentage correct) for individual emotions. We then investigated the specific-

Table 2. Overall Accuracy Mean Percentage and *SD* by Subtest of the DANVA2 and by Group

Subtest	Williams syndrome		Learning/intellectual disability		Typical controls	
	Mean	<i>SD</i>	Mean	<i>SD</i>	Mean	<i>SD</i>
Child Faces	78.28	10.7	76.36	13.5	89.58	7.3
Adult Faces	71.99	11.6	69.39	13.6	84.12	7.5
Child Voices	63.65	14.5	65.05	15.4	81.32	9.5
Adult Voices	58.06	12.7	61.65	12.2	75.72	9.6
Total Faces	75.13	9.7	72.87	11.7	86.85	6.0
Total Voices	60.86	11.4	63.35	11.7	78.52	8.2

Note. DANVA = Diagnostic Analysis of Nonverbal Accuracy Scale, 2nd ed.

ity of affect recognition abilities by emotion category and presentation modality. Table 3 shows the mean percentage correct recognition by group and presents a summary of the patterns of group differences for each emotion and modality.

Faces Subtest

For the facial modality, we conducted a 3 (group: Williams syndrome, learning/intellectual disabilities, typically developing individuals) $\times$ 4 (emotion: happy, sad, angry, fearful) ANOVA, with repeated measures on the last factor, which yielded significant main effects for group, $F(2, 151) = 35.67, p < .001$, emotion, $F(3, 149) = 88.97, p < .001$, and a significant Group $\times$ Emotion interaction, $F(6, 298) = 6.25, p < .001$. Follow-up post hoc comparisons, with significance level chosen at an alpha of .004 (Bonferroni correction for multiple comparisons), revealed that the typically developing group was significantly more accurate than were the two clinical groups on each of the three negative emotions (sad, angry, fear), but no group differences were found in identifying happy facial expressions (see Table 3). There were no significant differences in accuracy between the Williams syndrome and the learning/intellectual disabilities groups on any emotion in the Faces subtest.

Paralanguage Subtest

For the vocal modality, a similar 3 (group) $\times$ 4 (emotion) ANOVA with repeated measures on the last factor revealed main effects for group, $F(2, 151) = 45.66, p < .001$, emotion, $F(3, 149) = 42.34, p < .001$, and a significant Emotion $\times$ Group interaction, $F(6, 298) = 3.84, p < .001$. Follow-up post hoc comparisons (with significance level alpha = .004, Bonferroni correction) indicated that the individuals in the typically developing group were significantly more accurate than were those in either of the two clinical groups for each emotion, except happy, $p > .004$. There were no significant differences in accuracy between the Williams syndrome and the learning/intellectual disabilities groups on any emotion in the Paralanguage subtest.

Further similarities in patterns of performance were indicated by a separate ANOVA for each group, with modality (faces, paralanguage) and emotion (happy, sad, angry, fearful) as repeated measures. In each group, accuracy was higher when identifying emotions in facial expressions compared to vocal prosody: $F(1, 46) = 57.74, p < .0001$, for the Williams syndrome group; $F(1, 48) = 34.52, p < .0001$, for the learning/intellectual disabilities group; and $F(1, 57) = 37.46, p < .0001$, for the typically developing group. For

Table 3. Mean Percentage Accuracy and SDs by Emotion and Presentation Modality

Presentation/ Emotion	Williams syndrome			Learning/Intell. disability			Typical controls			Group differences
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	F pattern ^a
Facial modality										
Happy	91.31	7.9	66.7–100	90.65	10.7	58.3–100	93.39	8.4	66.7–100	1.35 ^{a,b,c}
Sad	77.13	20.3	25.0–100	75.68	19.3	33.3–100	87.07	11.7	58.3–100	7.06 ^{a,d,f}
Angry	65.96	17.0	16.7–100	63.27	21.8	0–91.7	82.76	11.9	50–100	20.67 ^{***a,d,f}
Fearful	66.13	20.6	0–100	61.90	21.9	8.33–100	84.19	12.3	50–100	22.4 ^{***a,d,f}
Vocal modality										
Happy	63.65	20.7	8.33–100	65.65	15.5	25–91.7	72.56	12.3	41.7–100	4.45 ^{a,d,f}
Sad	63.12	19.9	16.7–91.7	65.14	21.9	16.7–100	82.04	11.7	41.7–100	17.91 ^{***a,d,f}
Angry	74.47	16.4	41.7–100	72.45	16.5	33.3–100	85.92	11.6	58.3–100	14.05 ^{***a,d,f}
Fearful	42.19	23.6	0–91.67	50.17	27.9	0–100	73.56	16.7	33.3–100	27.29 ^{***a,d,f}

^aPatterns of group differences in percentage correct responses: ^aWilliams syndrome = learning/intellectual disabilities;

^bWilliams syndrome = typically developing individuals; ^clearning/intellectual disabilities = typically developing individuals;

^dWilliams syndrome < typically developing individuals; ^eWilliams syndrome < learning/intellectual disabilities;

^flearning/intellectual disabilities < typically developing individuals.

* $p < .001$. ** $p < .0001$.

each group, the Modality $\times$ Emotion interaction was significant, so we conducted pairwise comparisons for individual emotions separately for the Faces and the Paralanguage subtests.

In the facial modality, every group recognized happy expressions significantly better than sad, angry, and fearful expressions. In the Williams syndrome and learning/intellectual disabilities groups, recognition accuracy for sad facial expressions was also significantly better than for angry or fearful faces, whereas for the typically developing individuals, recognition accuracy for the three negative emotions did not differ significantly.

In the Paralanguage subtests, similarities in patterns of performance were also observed: The three groups most accurately recognized angry intonation in voices, whereas fearful intonation was generally the least well-recognized. The two clinical groups recognized fearful intonation significantly less often than any other vocal expression; angry intonation was recognized significantly better than the other emotions. For the typically developing individuals, happy and fearful vocal expressions were recognized at equivalent rates of accuracy and lower than for sad and angry.

Error Patterns: Types of Confusions

We first examined baseline error rates for each emotion to uncover possible labeling biases within each group. Each emotional expression appears in the DANVA2 subtests in equal proportions, (i.e., 25% of each expression: happy, sad, angry, fearful). For the Faces subtest, for all groups the label *happy* was used for more than 25% of the items, a tendency more pronounced in the Williams syndrome and learning/intellectual disabilities groups (30.9 and 31.9%, respectively). On the

Paralanguage subtest, all groups tended to use the label *sad* proportionally more than the other labels. The groups were not significantly different from each other in the relative proportion of labels used in either modality, and all used each label for at least 20% of the items, except for fearful by the Williams syndrome group for voices (18%). Overall, the proportional use of the four labels indicates a lack of consistent bias toward any specific emotion label in any of the groups.

Next, we analyzed the distribution of confusion patterns in each group by expressive modality (e.g., proportion of sad labels used for fearful target expressions). The confusion rates by the typically developing individuals were significantly lower than those in either the Williams syndrome or the learning/intellectual disabilities group for all confusion combinations, except between happy-angry in the facial modality. The Williams syndrome and learning/intellectual disabilities groups were very similar in the types and proportions of confusions, except for the confusion between happy and angry in the vocal modality, $t(94) = 2.86, p < .005$: The participants with Williams syndrome produced proportionally more of these misidentifications than did the learning/intellectual disabilities group, mainly by mislabeling happy intonation as being angry ($M_s = 19.5\%$ for the Williams syndrome vs. 12.76% for the learning/intellectual disabilities groups). We then considered most prevalent confusion pairs together, collapsed over direction. Results are summarized in Table 4. Even though the magnitude and proportion of confusions were different in the clinical versus the typically developing individuals for every pair, a similar pattern emerged. The most common confusions in all groups were between sad and fearful voices and between happy and angry

Table 4. Mean Percentage of Confusion Rates by Combined Pairs or Error Types By Modality

Confusion pairs	Faces			Voices		
	WS	LID	TDI	WS	LID	TDI
Happy-sad	1.56	2.38	1.01	5.63	6.04	2.91
Happy-angry	3.37	3.44	2.69	6.87	4.76	3.74
Happy-fearful	5.50	5.82	2.41	5.72	5.82	2.23
Sad-angry	5.59	6.80	2.73	4.48	4.63	2.73
Sad-fearful	3.68	3.99	2.37	12.23	11.73	8.76
Angry-fearful	5.19	4.68	1.94	4.17	3.66	1.11
Total confusions	24.89	27.11	13.15	38.65	36.64	21.48

Note. WS = Williams syndrome, LID = learning/intellectual disabilities, TDI = typically developing individuals.

voices. In the facial modality, confusion pairs were small in magnitude (overall less than 7% of total responses for each type of confusion), the most common confusion in all groups was between sad and angry expressions.

Relations With Cognitive Measures in the Clinical Groups

To examine possible specific contributions of cognitive measures and age to performance in the Faces and the Paralinguistic subtests, we entered K-BIT estimated IQ, PPVT standard scores, Benton scores, and age into regression analyses on DANVA2 accuracy for each group.

Faces subtest. In the Faces subtest, these variables together accounted for 25% of the variance, $F(4, 41) = 3.39, p < .02$, for the Williams syndrome group. When using a forward stepwise procedure, we found that the only significant predictor entered was the vocabulary variable (PPVT scores), which accounted for 13.6% of the variance in accuracy scores for the Faces subtest, $R^2 = .13, F(1, 44) = 6.94, p < .02$. None of the other variables contributed significantly to the model. For the learning/intellectual disabilities group, the combination of cognitive variables (IQ, PPVT standard scores, Benton scores) and age accounted for 13% of the variance on the Faces subtest, but this was not significant, and a forward stepwise procedure did not enter any of these variables into the model.

Paralinguistic subtest. Similar results for the Williams syndrome group were obtained in the Paralinguistic subtest of the DANVA2. When IQs, PPVT standard scores, and age were entered into a regression analysis, these variables together accounted for 25.1% of the variance in emotion recognition accuracy for voices, $F(3, 43) = 4.80, p < .01$. A forward stepwise procedure entered only PPVT scores as a significant predictor, $R^2 = .16, F(1, 45) = 8.86, p < .01$, which explained 16.5% of the variance in performance on the Paralinguistic subtest for the Williams syndrome group. For the learning/intellectual disabilities group, these variables together accounted for 13% of the variance, but this was not significant and the forward stepwise procedure did not enter any of these variables in the model.

Discussion

We investigated the ability of adolescents and adults with Williams syndrome to perceive basic

emotional expressions in faces and voices, using a standardized measure—the DANVA2. The main findings were that the group with Williams syndrome performed significantly less accurately than did age-matched typical controls, but similarly to a group of age, IQ, and language-matched participants with learning/intellectual disabilities. Despite the differences in overall accuracy, the general pattern of performance across the different subtests and modalities was similar in all three groups; all were better able to identify emotions in faces than in voices, in children than in adults. Although we cannot rule out a possible order effect on performance (given the fixed administration order of the four subtests), our results replicate findings reported in other studies using the DANVA2 regarding modality and test version differences in emotion recognition and show that the same pattern is found in people with Williams syndrome. When examining accuracy for individual emotions by modality of expression, the Williams syndrome and learning/intellectual disabilities groups were similar on all of the eight possible comparisons. Both clinical groups were significantly less accurate than the typically developing individuals on seven of the eight comparisons, the only exception being recognition of happy facial expressions, the sole positive emotion included on the DANVA2, on which all groups achieved near ceiling levels.

Thus, despite their unique social phenotype, we did not find the participants with Williams syndrome to be better in either facial or vocal emotion recognition compared to a group with learning or intellectual disability, matched closely on age, IQ, and language ability. These findings from a large well-characterized sample of people with Williams syndrome indicate that emotion recognition is not even relatively spared in Williams syndrome, confirming earlier small-scale studies on young children (Tager-Flusberg & Sullivan, 2000) and children and adults with Williams syndrome (Gagliardi et al., 2003).

This study provides further evidence that face identification and recognition of facial expressions follow relatively independent processing routes in individuals with Williams syndrome, as has been suggested for typically developing individuals and children with mental retardation (Bruce & Young, 1986; Etcoff, 1984; Hay & Young, 1982; Singh et al., 2005). Whereas the group with Williams syndrome performed at the same level as the typically developing individuals (and better than the group

with learning/intellectual disabilities) on the Benton test of facial recognition, their performance was worse than the typically developing individuals' performance on the DANVA2, a standardized test of facial emotions. Thus, this unique pattern of performance in Williams syndrome on these two kinds of face recognition tests adds to the cognitive neuroscience literature on separable mechanisms that subserve the identification of faces and emotions (e.g., Haxby, Hoffman, & Gabbini, 2000). According to the model developed by Haxby and his colleagues, face perception is mediated by a distributed neural system that involves a distinction between the representation of invariant aspects of faces, which is crucial for face identification, and the representation of changeable aspects, such as facial expression, which underlies the perception of information that facilitates social communication. Evidence from this study and from Bellugi et al. (1999) suggests that this extended neural system may be specifically impaired in Williams syndrome. Similar findings suggestive of different cognitive processes involved in analyzing facial expressions and facial identity have been recently reported for 10- to 12-year-old children with mild mental retardation, based on a reaction time methodology (Singh et al., 2005).

Although the Williams syndrome and learning/intellectual disabilities groups performed significantly worse than did the typical controls on the DANVA2, these findings should be qualified by noting the large individual variability in their performance. In both clinical groups approximately 40% of participants performed within the range of accuracy of the typically developing individuals; for the facial expression modality alone, the proportion rose to 73% in the Williams syndrome and 70% in the learning/intellectual disabilities group. The only significant predictor of performance on emotion recognition was found for the Williams syndrome group; language ability, as assessed by the PPVT, predicted performance on the DANVA2 for the participants with Williams syndrome, but not for the etiologically more heterogeneous learning/intellectual disabilities group.

The similarities in the impaired performance of the Williams syndrome and learning/intellectual disabilities groups are consistent with other research on emotion recognition in people with mental retardation; most investigators have found deficits in recognizing emotions by comparison to

typically developing individuals (see Rojahn, Lederer, & Tassé, 1995, for a review). Although numerous studies have been conducted with participants who have mental retardation, few researchers have examined how such impairments may relate to specific etiologies of mental retardation. Our findings suggest that impairments in emotion recognition may be relatively similar across different types of etiology.

The role of IQ or MA in emotion recognition accuracy remains unclear from prior research with people who have mental retardation. Several researchers found positive correlations between degree of mental retardation (or IQ) and the ability to recognize facial expressions of emotion (Gray, Fraser, & Leudar, 1983; Maurer & Newbrough, 1987; McAlpine, Singh, Kendall, & Ellis, 1992; Simon, Rosen, & Ponpipom, 1996); however, the nature of the relations between the perception of emotion cues and cognitive processes remains largely unspecified (Kroeger, Rojahn, & Naglieri, 2001) and appears to differ depending on participants' CA (Adams & Markham, 1991). In contrast, investigators using the DANVA in the general population have found no significant correlations with IQ (Nowicki & Duke, 1994). Moreover, the decline in recognition of some emotional expressions in older people was found to be largely independent of changes in fluid IQ, basic face-processing, and perceptual abilities (Sullivan & Ruffman, 2004). Our findings using the DANVA2 with participants who have Williams syndrome and learning/intellectual disabilities support the latter studies, suggesting that recognition of emotional expressions is not closely tied to IQ. Across this body of research, investigators have used different tasks to tap emotion recognition, including match-to-sample, labeling, discrimination, and rating tasks, although many have used similar stimuli, such as the Ekman and Friesen (1976) emotional faces series. It is possible that different types of tasks tap different emotion-processing mechanisms, complicating the picture of cognitive versus perceptual contributions to emotion recognition performance.

In this study the pattern of performance across all groups was similar. The best recognized facial expression of emotion was happy, while in the vocal modality angry intonation was correctly labeled more often than any other vocal expression in every group. Moreover, the distribution of types of confusions within groups was similar, despite significant differences in the magnitude of

confusion pairs between the typically developing individuals and the two clinical groups. We speculate that the commonality in several patterns of confusion may be related to the characteristics of the stimuli in the DANVA2 test. Some of the facial displays may lend themselves to certain confusions, for example, fearful expressions that were interpreted as showing surprise. These may have been labeled happy because of positive valence associated with surprise. Similarly, for vocal expressions, high intensity happy and angry voices share acoustic features (e.g., pitch, volume) that may lead to confusions.

An examination of the emotion labels used by each group did not show significant biases for any label. The expectation of a specific happy bias in interpreting emotional expressions by the Williams syndrome compared to control groups was not confirmed, replicating findings reported by Gagliardi et al. (2003). Instead, it appears that a tendency to label facial expressions as happy is common in different groups with mental retardation.

Why do people with developmental disabilities, especially people with Williams syndrome, have difficulty recognizing emotional expressions? Asserting limitations of their perceptual system in discriminating facial or auditory patterns is not a likely explanation given that the group with Williams syndrome performed so well on the Benton test, which also entails discriminating facial patterns. Other studies on sensitivity to emotion in vocal prosody with typically developing children found that this was not related to measures of auditory discrimination (e.g., Baum & Nowicki, 1998).

An alternative explanation, at least for the facial expressions, is that the clinical groups may be using a general category of negative affect in interpreting emotions before becoming more adept at differentiating among emotions of the same valence, and then accurately applying the specific labels. This fits with the pattern of performance showing excellent accuracy for the single positive facial expression (happy), but more difficulty discriminating among the negative facial expressions (sad, fearful, and angry). This interpretation is consistent with findings discussed by Adolphs (2002), namely, that facial emotional expressions are initially categorized into the superordinate categories of happy and unhappy and then into more subordinate categories and that damage to temporal neocortices can result in selective impair-

ments in recognition of subordinate emotion categories, with sparing in recognition of superordinate levels.

Another interpretation for the impairments in emotion recognition found in this study stresses the involvement of language-processing in this task. The task used, the selection of an emotion label, involves language-mediated processes that engage cortical areas that may interfere with processing of perceptual information, which in part involves subcortical structures, especially the amygdala. Support for this explanation, at least for the participants with Williams syndrome, comes from the finding that language ability, as assessed by the PPVT, was a significant predictor of performance on both facial and vocal expressions of emotion for this group.

A limitation of the DANVA2 is that it reduces the complexity of emotional information typically conveyed in real-life situations. Responses are restricted to four basic emotion categories and more subtle emotional expressions (e.g., surprise, disgust, embarrassment) are not included. The information conveyed by each stimulus is limited to still photos in the Faces subtest and to the repetition of the same sentence in the Paralanguage subtest, creating a relatively restricted testing environment compared to the complexities of real-life social interaction. Further studies with a broader range of emotions and more ecologically valid stimuli may further elucidate the difficulties experienced by individuals with Williams syndrome as well as the possible links between emotion decoding and specific etiologies of mental retardation.

In conclusion, we found that people with Williams syndrome are not spared in the capacity to recognize basic emotional expressions in either faces or voices. The impairments among the adolescents and adults with Williams syndrome in recognizing emotions may partially explain some of their social difficulties, especially in peer relationships. In the future, researchers investigating social-emotional abilities in Williams syndrome should extend this line of study to the interpretation of nonverbal cues in dynamic displays, more similar to the demands in everyday life, and explicitly explore the relationship between emotion recognition and social adaptation. In addition, studies are needed to investigate the neurocognitive bases of emotion recognition in Williams syndrome. This work will further our understanding of the social phenotype of Williams

syndrome and may provide unique insights into the fundamental neurocognitive mechanisms that support social-affective information-processing.

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