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Facial mimicry is not necessary to recognize emotion: Facial expression recognition by people with Moebius syndrome

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According to the reverse simulation model of embodied simulation theory, we recognize others' emotions by subtly mimicking their expressions, which allows us to feel the corresponding emotion through facial feedback. Previous studies examining whether facial mimicry is necessary for facial expression recognition were limited by potentially distracting manipulations intended to artificially restrict facial mimicry or very small samples of people with facial paralysis. We addressed these limitations by collecting the largest sample to date of people with Moebius syndrome, a condition characterized by congenital bilateral facial paralysis. In this Internet-based study, 37 adults with Moebius syndrome and 37 matched control participants completed a facial expression recognition task. People with Moebius syndrome did not differ from the control group or normative data in emotion recognition accuracy, and accuracy was not related to extent of ability to produce facial expressions. Our results do not support the hypothesis that reverse simulation with facial mimicry is necessary for facial expression recognition.

Keywords: Facial feedback; Mimicry; Moebius (Mobius) syndrome; Embodied simulation theory; Emotion recognition.

INTRODUCTION

Psychologists have long been interested in how people "mindread" the emotional states of others. Recently, embodied simulation theories have sought to explain emotional mindreading by suggesting that people recognize emotion in others by simulating the emotion experience within themselves (Goldman & Sripada, 2005). One version of the theory, the *reverse simulation model*, suggests that people recognize facial expressions by mimicking observed expressions, which in turn generates the corresponding emotional experience in the observer (Goldman & Sripada, 2005; Lipps, 1907; Neidenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Oberman, Winkielman, & Ramachandran, 2007; Stel & van Knippenberg, 2008). Thus, the process of expression recognition is inextricably linked with one's own facial expressions. But what happens when someone cannot mimic the facial expressions of others? Studying individuals with Moebius syndrome, a condition characterized by congenital bilateral facial paralysis, may lend

insight into this question. The reverse simulation model would predict that since people with Moebius syndrome cannot mimic facial expressions, they should have difficulty recognizing them. We examine this hypothesis in this study.

THE REVERSE SIMULATION MODEL

Reverse simulation is proposed to be a three-step model (Goldman & Sripada, 2005; Lipps, 1907). First, during emotion recognition, an observer mimics an expression, presumably in a subtle and covert manner. Second, facial feedback generates the corresponding emotional state in the observer. Third, the observer understands or classifies the emotion he or she is experiencing as the emotion expressed by the other person. Cited in support of the first part of the model, there is evidence that when presented with pictures of facial expressions, people spontaneously and rapidly but covertly mimic facial expressions (Dimberg & Thunberg 1998; Dimberg, Thunberg, & Elmehed, 2000; Lundqvist & Dimberg, 1995. The second part of this model is grounded in the facial feedback hypothesis, which proposes that proprioceptive feedback from facial expressions is either necessary or sufficient to affect the experience of emotion (Izard, 1971; Tomkins 1962, 1963).

Much of the evidence cited in support of the role of embodied simulation in emotion recognition has been from correlational neuroimaging studies, which cannot identify whether facial mimicry is a functional component of emotion recognition or a by-product of the process (Atkinson, 2007). Indeed, in a study in which participants' facial movements were measured by electromyography (EMG) while they performed an emotion recognition task, Blairy, Herrera, and Hess (1999) found that participants spontaneously mimicked the facial expression stimuli and reported congruent emotions, but there was no correlation between these phenomena and emotion recognition accuracy. In a second study, Blairy et al. instructed participants to either mimic the facial expression shown or perform an incompatible expression while performing an emotion recognition task. Again, they found that the mimicry manipulation did not affect self-reported emotion or emotion recognition accuracy. While this study supported evidence that facial mimicry and the experience of congruent emotions occur during emotion recognition, it did

not support a mediational role of mimicry in emotion recognition.

Several researchers since Blairy et al. (1999) have attempted to identify a causal role for facial mimicry by artificially restricting or blocking facial mimicry during emotion recognition tasks (Neidenthal et al., 2001; Oberman et al., 2007; Stel & van Knippenberg, 2008). In these studies, mimicry was blocked by instructing participants to perform tasks such as holding pens in their mouths or chewing gum. In contrast to the findings of Blairy et al., these subsequent studies found emotion recognition deficits in blocked mimicry conditions, purportedly lending support to the role of reverse simulation and mimicry in emotion recognition. However, the mimicry restriction manipulations were potentially distracting and could have caused the deficits in the restricted movement conditions. Oberman et al. (2007) and Stel and Knippenberg (2008) attempted to control for distraction effects by instructing ''control'' participants to perform concurrent tasks (i.e. hold pens in their lips or hold their shoulders still, respectively). However, it is not known whether these ''control'' manipulations caused the same level of distraction as the experimental manipulations, so emotion recognition deficits in the blocked mimicry conditions relative to ''controls'' could have been caused by increased distraction in the blocked mimicry conditions. These blocked mimicry manipulations were also problematic because the researchers could not block all facial movements involved in facial expression; typically only the mouth was restricted (Neidenthal et al., 2001; Oberman et al., 2007; Stel & Knippenberg, 2008). Since most of the basic facial expressions of emotion involve global facial movements, participants in those studies could simulate the facial expressions with other parts of the face, such as their eyebrows.

MOEBIUS SYNDROME

People with Moebius syndrome have complete, or near complete, facial paralysis and are thus an ideal population to test as to whether facial mimicry is necessary for emotion recognition. Moebius syndrome is a congenital, non-progressive condition characterized by facial paralysis, which is usually complete and bilateral, and impaired lateral movement of the eyes (Briegel, 2006; Möbius, 1888). The syndrome is associated

with the maldevelopment or underdevelopment of the sixth and seventh cranial nerve nuclei which occurs early in prenatal life (Briegel, 2006). Moebius syndrome is extremely rare; the prevalence is estimated to be 0.0002–0.002% of births, (Kuklik, 2000; Verzijl, van der Zwaag, Cruysberg, & Padberg, 2003). There are around 2000 known cases, with approximately 800 of these individuals living in the USA (McCarrell, 2003). Other congenital conditions are sometimes associated with the syndrome, the most common being limb anomalies such as club feet and missing or underdeveloped fingers or hands (Richards, 1953; Verzijl et al., 2003).

Moebius syndrome is one of the only conditions that results in bilateral facial paralysis while typically sparing health and cognitive function. Many people with Moebius syndrome are psychologically well-adjusted, resilient, and professionally successful (Bogart & Matsumoto, in press; Meyerson, 2001). Bogart and Matsumoto found no increased incidence of anxiety or depression or decreased subjective well-being in people with the condition compared to a matched control group and normative data. However, they found that people with Moebius syndrome experienced increased social interaction difficulty, and an emotion recognition deficit could contribute to these social interaction problems. There have been several reports of high rates of mental retardation and autism in people with Moebius syndrome, with incidences estimated as high as 10–15% for mild mental retardation and 5–29% for autism (Bandim, Ventura, Miller, Almeida, & Costa, 2003; Gillberg & Steffenburg, 1989; Johansson et al., 2001). However, recent studies have suggested that the high incidence of mental retardation and autism found previously may have been inflated due to selection biases and poor methodology (Briegel, Schimek, Kamp-Becker, Hofmann, & Schwab, 2009; Ghabrial, Versace, Kourt, Lipson, & Martin, 1998; Verzijl, van Es, Berger, Padberg, & van Spaendonck, 2005).

The impairment in Moebius syndrome originates in the pons (Verzijl et al., 2003), and it appears that higher-level structures such as the limbic system and motor cortex are intact. O'Sullivan and Ekman (2006) reported that people with Moebius syndrome showed the same pattern of autonomic responses to emotional stimuli as the normal population, even though they were not able to produce facial expression. Thus, if people with Moebius syndrome are unable to recognize facial expressions of emotion, this will provide evidence that facial mimicry is specifically important for emotion recognition. If they can recognize facial expressions, facial mimicry is not necessary for emotion recognition. It is important to consider that people with Moebius syndrome may have developed compensatory mechanisms to facilitate emotion recognition that are different from the processes used by typical people (Goldman & Sripada, 2005).

PREVIOUS STUDIES OF EMOTION RECOGNITION IN PEOPLE WITH FACIAL PARALYSIS

There have only been a few small studies of facial expression recognition ability in people with facial paralysis (Calder, Keane, Cole, Campbell, & Young, 2000; Giannini, Tamulonis, Giannini, Loiselle, & Spirtos, 1984; Keillor, Barrett, Crucian, Kortenkamp, & Heilman, 2002), and it is difficult to evaluate the results of these studies because of small sample sizes and conflicting results. Keillor and colleagues (2002) reported a case study of a woman with temporary bilateral facial paralysis caused by Guillain-Barre syndrome. Despite having complete facial paralysis, the woman did not show impairments in the experience, recognition, or mental imagery of facial expressions. However, in another case study, Giannini et al. (1984) described a woman of reportedly normal intelligence with Moebius syndrome who was completely unable to perform a facial expression recognition task.

Calder et al. (2000) completed an emotion recognition study with three participants with Moebius syndrome and a control group of 40 normal participants. Participants with Moebius syndrome showed no impairment on tests of recognition of emotional sounds and prosody. Participants also completed facial expression recognition tasks with Ekman and Friesen's (1976) photographs of six basic emotions and computer-morphed versions of the photographs of facial expressions. The participants with Moebius syndrome were not significantly impaired on the photograph recognition task, but all three participants made at least three more incorrect judgments than the control group mean. Using information provided in the paper, we calculated an effect size $d = .98$ representing the difference in accuracy between groups, which is a large effect according to Cohen's (1992) guidelines.

In a computer-morphed expression recognition task, compared to the control group, one participant with Moebius syndrome was unimpaired, one showed mild deficits that approached significance, and one was significantly impaired. Again, we calculated an effect size $d = 1.32$ representing the difference in accuracy between groups, which is a large effect. Contrary to the most extreme interpretation of the reverse simulation model, which would suggest that facial mimicry is *necessary* for facial expression recognition, Calder and colleagues established that people with Moebius syndrome were able to recognize facial expression to some extent. However, it is unclear whether the facial expression recognition deficits observed in their sample are widespread among people with Moebius syndrome.

PRESENT STUDY

Studying the emotion recognition ability of people with Moebius syndrome obviates two issues common to embodied simulation studies in which facial movement has been artificially restricted, including the possible distraction caused by the restriction method itself and the inability to restrict movement in all areas of the face. Further, the present study addresses several limitations in the previous studies of emotion recognition by people with facial paralysis. First, bilateral facial paralysis is a very rare occurrence, and previous studies on these conditions had very small samples. We took a novel approach to achieve a large sample by conducting the study on the Internet so that individuals with Moebius syndrome from all over the USA could participate. We present data from 37 participants with Moebius syndrome, making this the largest sample of people with Moebius syndrome in a psychology study to date. Second, previous studies compared the performance of people with facial paralysis to normative data or an unmatched control group. We compared participants with Moebius syndrome to both normative data and a control group of participants without facial movement disorders who were matched on age and gender. Third, we included an additional emotion, contempt, which has been identified as a probable seventh universal emotion (Ekman & Friesen, 1986; Matsumoto & Ekman, 2004). Fourth, the emotion recognition tasks in the previous studies only included photographs of Caucasians, and thus would not measure recognition accuracy of the variations in emotional expression due to different facial physiognomies that occur across ethnicities. We included equal numbers of photos of African American, Caucasian, and Hispanic expressors in our facial expression recognition task, which represent the three most prevalent ethnicities in the USA (United States Census Bureau).

To test the reverse simulation model, we hypothesized that people with Moebius syndrome would be less accurate in an emotion recognition task compared to an age and gender matched control group and normative data. Although most people with Moebius syndrome have complete bilateral facial paralysis, some have incomplete paralysis and may be able to form one or more meaningful expressions. Thus, we also hypothesized that in people with Moebius syndrome, the amount of impairment in producing basic facial expressions would be related to accuracy in recognizing facial expression of emotion.

METHOD

Participants

Adults (18 and older) with Moebius syndrome were recruited through notices in the USA-based Moebius Syndrome Foundation (MSF) newsletter, on the MSF website, and personal contacts obtained through the MSF and its conferences. Participants received no financial incentives to participate in the study. A total of 31 participants indicated by self-report that they had been diagnosed with Moebius syndrome. Seven participants indicated that they had not been formally diagnosed with Moebius syndrome, but they believed that they had the condition. Six of these self-diagnosed participants indicated some difficulty with facial movement and moving their eyes laterally. Since Moebius syndrome is very rare, some people with the condition are never properly diagnosed by a physician. Facial weakness and impaired ocular abduction are the minimum inclusion criteria used for most studies on Moebius syndrome (Briegel, 2006, 2007; Cronemberger et al., 2003; Meyerson & Foushee, 1978; Stromland et al., 2002), so these six participants were included in the analyses in the Moebius syndrome group. One self-diagnosed participant indicated difficulty with facial movement and smiling, but he reported he was able to move his eyes laterally. This participant did not meet the

minimum inclusion criteria and was not included in further analyses. Thus, there were a total of 37 participants (23 female, 14 male) in the Moebius syndrome group. In this group, 33 participants (89.2%) identified themselves as Caucasian, 2 (5.4%) as Native American, 1 (2.7%) as Hispanic/Latino, and 1 (2.7%) as ''other''.

A total of 249 participants for the control group were recruited through San Francisco State University's student participant database and completed the study for partial course credit. Thirty-seven participants (23 female, 14 male) were selected from this dataset to match the participants in the Moebius group on age and gender as closely as possible. The age difference between the Moebius group ($M = 37.53$, $SD = 13.84$, range $= 18$–66) and the control group ($M = 35.19$, $SD = 12.62$, range $= 19$–60) was not significant, $t(72) = .79$, $p = .43$, $d = .19$. The data from the remaining control participants were not used for this study. In the control group, 28 (75.7%) identified themselves as Caucasian, 4 (10.8%) as African-American, 4 (10.8%) as Asian, and 1 (2.7%) as Hispanic/Latino. Participants in the control group indicated that they had never experienced facial movement problems.

Measures

Facial expression recognition

A total of 42 photos from Matsumoto and Ekman's (2006) Multi-Ethnic Facial Expression Set were used for the facial expression recognition task. To develop this set, facial expressions were posed by actors and subsequently coded with the Facial Action Coding System to verify that they included the facial muscle configurations that previous research has identified as signaling specific emotions (Ekman & Friesen, 1978). Each photo displayed one of the seven emotions (anger, contempt, disgust, fear, happiness, sadness, and surprise) found to be universally produced and recognized across cultures (Ekman & Friesen, 1971, 1986; Ekman, Sorenson, & Friesen, 1969; Elfenbein & Ambady, 2002; Matsumoto & Willingham, 2009).

The expressors in the photos selected for this study represented the three largest ethnic groups in the USA (Caucasian, African-American, and Hispanic), with equal numbers of males and females in each group and each emotion expressed an equal number of times. Photos were presented one at a time, in color, and participants could view the photo for an unlimited length of time. For each photo, participants indicated which emotion was being expressed by selecting from a list of response choices one of the seven emotions, neutral, or other. We included an ''other'' category because it has been shown to prevent artificially forced agreement (Frank and Stennett, 2001).

Several researchers have suggested that the Internet can be a useful tool for many cognitive and social psychological studies, particularly for collecting large samples of rare populations, and that comparisons of Internet-based studies with lab-based studies showed that results are consistent across presentation modes (Gosling, Vazire, Srivastava, & John, 2004; McGraw, Tew, & Williams, 2000). Our group has conducted several Internet-based facial expression recognition studies (e.g. Matsumoto, Olide, Schug, Willingham, & Callan, in press), and the recognition accuracy rates are commensurate with data collected in lab settings. Other researchers have also conducted Internet-based emotion recognition studies (Hänggi, 2004; Mathersul et al., 2008; Williams et al., 2008).

Facial Expression Communication Questionnaire (FECQ)

This measure was created for this study to assess the self-reported ability to communicate the seven universal emotions with the face. One purpose of this measure was to confirm that participants with Moebius syndrome were impaired in facial expression of emotion compared to the control group. A similar set of questions was used by Coulson, O'Dwyer, Adams, and Croxson (2004) to determine whether participants with unilateral facial paralysis were able to form facial expressions. There were seven items in the FECQ, each measuring the ability to communicate one of seven basic emotions. An example is: ''I can communicate anger with my facial expression.'' Response choices were ''strongly agree,'' ''agree,'' ''disagree,'' and ''strongly disagree.'' Items were reverse coded, such that a higher score indicated more ability to communicate emotion. Cronbach's αs for this study were high for both the Moebius group ($\alpha = .94$) and the control group ($\alpha = .87$). FECQ results from this sample were reported for a different analysis in another paper (Bogart & Matsumoto, in press), but the findings reported here are unique to this paper.

Demographics and additional questions

Participants also completed demographic questions and indicated whether they had been diagnosed with mental retardation or psychological disorders. Questions about the presence of symptoms noted in the literature to occur with Moebius syndrome were included in the demographic section for the Moebius group.

Procedure

This study received IRB approval from San Francisco State University, and participants indicated implied consent at the beginning of the Internet-based study. All tasks were computerized. During the Internet session, participants also completed adjustment measures for the purposes of another study which is reported elsewhere (see Bogart & Matsumoto, in press). There were eight counterbalanced versions of the study for each condition, with the demographic questions always placed at the end. Participants were randomly assigned to a version of the study.

RESULTS

Preliminary analyses

To ensure that our data did not contain multiple responses from the same individual, we checked for two or more responses from the same IP address. No duplicate responses were found. Two participants in the Moebius group (5%) reported having been diagnosed with mental retardation at some point in their lives, compared to none in the control group. No participant in either group reported a diagnosis of an autistic spectrum disorder. As predicted, people with Moebius syndrome ($M = 16.19$, $SD = 6.53$) had significantly less ability to communicate emotion with their faces compared to the matched control group ($M = 25.89$, $SD = 3.06$) as measured by the FECQ, $t(72) = -8.19$, $p < .001$, $d = -1.93$.

Emotion recognition accuracy scores were calculated for each participant and represented the percentage of emotions correctly identified from the photoset. An outlier in the Moebius group with a z score of -4.19 calculated from the Moebius group emotion recognition accuracy mean was identified. This participant's emotion recognition accuracy score was 31, which was substantially lower than the rest of the accuracy scores in the Moebius group, with the next lowest score being 60 (a z score of -1.31). Following the recommendations of Tabachnik and Fidell (2006), this participant and the matched control participant were removed from further analyses. With the outlier removed, the accuracy scores ranged from 60 to 90 ($M = 73.67$, $SD = 7.00$) in the Moebius group and 52 to 93 in the control group ($M = 75.44$, $SD = 7.25$).

Hypothesis 1: People with Moebius syndrome will be less accurate in the facial expression recognition task compared to people without Moebius syndrome.

A mixed 2 (Moebius or control group) × 7 (expressor emotion) ANOVA, with expressor emotion as a within-participants factor, was conducted on the emotion recognition accuracy scores. There was no significant main effect of group, which indicated that there was not a significant difference in overall recognition accuracy between people with Moebius syndrome and matched controls, $F(1, 68) = 1.08$, $p = .30$, $r = .07$. Additionally, the interaction of group by emotion was not significant, indicating that people with Moebius syndrome did not differ from controls in their recognition accuracy of each of the seven emotions, $F(6, 68) = 0.73$, $p = .65$, $r = .10$. There was a significant main effect of emotion, indicating that participants in both groups were able to recognize some emotions more accurately than other emotions, which is a typical finding in emotion recognition studies, $F(6, 68) = 90.77$, $p < .001$, $r = .76$. This effect is not discussed further because it is not relevant to our hypotheses.

We also compared the emotion recognition accuracy of people with Moebius syndrome to normative accuracy data for this photoset by calculating one-sample t tests for each of the seven emotions (see Table 1). The Moebius participants did not differ significantly from normative data on emotion recognition accuracy for any of the emotions. For several emotions, the Moebius participants had *higher* accuracy scores than normative data, and these differences represented a small effect size but did not reach significance.

Hypothesis 2: In people with Moebius syndrome, amount of impairment in producing facial expressions will be associated with facial expression recognition accuracy.

TABLE 1
One-sample *t*-tests on emotion recognition percentage accuracy for the Moebius group compared to normative data

Emotion	Moebius group		Normative data					
	M	SD	M	df	T	Sig.	d
Anger	86.11	16.67	81.80	35	1.55	0.13	0.26
Contempt	32.41	27.87	25.40	35	1.51	0.14	0.25
Disgust	61.90	23.77	62.40	34	−0.12	0.90	0.02
Fear	69.44	22.71	73.10	35	−0.97	0.34	0.16
Happiness	85.65	5.85	84.70	35	0.97	0.34	0.16
Sadness	91.20	13.50	91.20	35	0.00	0.99	0.00
Surprise	89.05	18.05	85.80	34	1.06	0.30	0.18

In participants with Moebius syndrome, self-reported ability to produce facial expression as measured by FECQ was not correlated with facial expression recognition accuracy, $r = .04$, *ns*.

DISCUSSION

This study examined the prediction that, according to the reverse simulation model, people with Moebius syndrome, who are unable to mimic expressions and experience facial feedback, will have difficulty recognizing emotions. People with Moebius syndrome did not differ from the matched control group or normative data in facial expression recognition accuracy. The fact that our sample of adults with Moebius syndrome did not show widespread deficits in emotion recognition accuracy shows that facial mimicry and facial feedback are not necessary to recognize facial expression. Furthermore, facial expression recognition accuracy in the Moebius syndrome group was unrelated to self-reported impairment in producing basic facial expressions.

Our results do not support the hypothesis that reverse simulation with facial mimicry is necessary for facial expression recognition, and they are in line with the findings of Blairy et al., (1999) that facial mimicry is not related to emotion recognition accuracy. Our findings are consistent with several emotion recognition theories that do not implicate mimicry as necessary for emotion recognition. During the reverse simulation process, it is possible that commands to mimic facial expression produce the experience of the corresponding emotions, even without peripheral facial feedback. This is similar to the idea proposed by Ekman (1992), that there may be a central command center such as the motor cortex that produces patterned, emotion-specific changes in multiple systems, including the limbic system, face, and autonomic nervous system, when it sends commands to form a facial expression. Essentially, this view suggests that the feedback source is not peripheral facial movement; instead, the feedback occurs earlier, from the neural commands to mimic facial expression. Similarly, the *reverse simulation with as-if loop model* suggests that representations of what it would feel like to generate the observed expressions in the motor or somatosensory cortices may allow the observer to simulate the emotion experience and recognize emotion (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Damasio, 1994; Gallese, Keysers, & Rizzolatti, 2004; Leslie, Johnson-Frey, & Grafton, 2004). Another possible explanation is emotional contagion, which suggests that simply viewing others' facial expressions directly elicits the corresponding emotional experience in the observer (Hatfield, Cacioppo, & Rapson, 1994; Wild, Erb, & Bartels, 2001). Finally, people may use rule-based computation processing rather than embodied simulation (see Adolphs, 2002). Facial mimicry is not an important mechanism in any of these theories, but mimicry may be observed in people without facial paralysis as a by-product of the theorized processes. Our study does not allow us to comment on the relative validity of the theories described above, other than to assert that our results do not support that facial mimicry is a necessary part of the emotion recognition process. For detailed reviews of, and critiques of the evidence for, theories of emotion recognition, see Atkinson (2007) and Goldman and Sripada (2005).

Another possible explanation is that people with Moebius syndrome, who have lived without the ability to mimic facial expressions for their entire lives, have developed compensatory mechanisms for emotion recognition and do not use the same neural pathways as typical people. Results from studies on facial mimicry in people

with autism may help explain the results from the present study. McIntosh, Reichmann-Decker, Winkielman, and Wilbarger (2006) found that people with autism did not automatically mimic facial expressions when presented with photo stimuli. The findings on emotion recognition accuracy in people with autism have been mixed, with some studies showing impairments and others not. If people with autism do not mimic facial expressions, it is possible that lack of mimicry presents a disadvantage in recognition tasks that require quick responses, but if they are given sufficient time, they can use compensatory intentional processes to correctly recognize emotions (McIntosh et al., 2006). This is supported by the finding that people with autism show activation of brain regions associated with intentional attention allocation and categorization rather than automatic processing during judgment tasks (Hall, Szechtman, & Nahmias, 2003). Along the same line of reasoning, people with Moebius syndrome may use intentional compensatory mechanisms instead of facial mimicry, allowing them to recognize emotions with normal accuracy, but possibly at a lower speed.

Our study did not find the facial expression recognition deficits observed by Calder et al. (2000) and Giannini et al. (1984). We believe our results hold weight because we made several methodological improvements to these studies, including collecting a larger sample of participants with Moebius syndrome. Our results also differed from several studies in which mimicry was manipulated experimentally (Neidenthal et al., 2001; Oberman et al. 2007; Stel & van Knippenberg, 2008). We suggest two possible explanations for these differences. First, experimentally restricting mimicry in previous studies may have distracted participants and impaired their performance on the judgment task. Second, recognizing facial expressions without facial mimicry may require compensatory mechanisms, which participants in the artificially blocked mimicry studies had not had time to develop since their mimicry restrictions were novel and temporary.

There are some limitations to consider when interpreting the results of the judgment task. Since the control group in our study was composed of university students and the Moebius group was sampled from a wider population and included two participants who reported having been diagnosed with mental retardation, it is possible that the control group had a higher average IQ. There is evidence that lower IQ is associated with lower emotion recognition accuracy when IQ is in the mental retardation range (Moore, 2001; Simon, Rosen, & Ponpipom, 1996). We included the participants who reported being diagnosed with mental retardation in our analyses because we did not measure IQ ourselves, and given the recent findings that reports of mental retardation incidences in Moebius syndrome may be inflated, we reasoned that these participants could have been misdiagnosed. If there were an influence of IQ on accuracy, one would expect that the Moebius group would show deficits in emotion recognition accuracy. Despite this possibility, we still found that the groups did not differ in emotion recognition ability. Thus, our findings that people with Moebius syndrome did not differ in emotion recognition ability from controls are robust to the possibility that the Moebius group may have had lower average IQ.

It is possible that the participants with Moebius syndrome self-selected in such a way that more high-functioning people participated, particularly because the study was Internet-based, and that the outlier that was removed from analyses was representative of a lower-functioning group. It is also possible that the facial expression recognition ability of the true population of people with Moebius syndrome forms a bimodal distribution. However, even when considering the performance of the outlier, most people with Moebius syndrome were able to recognize many facial expressions, and we can conclude that facial paralysis does not result in widespread deficits or the complete inability to recognize facial expression of emotion.

There is much to be learned from and about Moebius syndrome, and we hope that this paper encourages others to study the condition. To test whether people with Moebius syndrome are using slower intentional mechanisms rather than possible automatic mechanisms used by the typical population, a future study could test the performances of people with Moebius syndrome on a facial expression recognition task in which facial expression stimuli are flashed at microexpression speed (0.04–0.2 s; Ekman, 2003). Additionally, fMRI studies comparing people with and without Moebius syndrome could identify whether different areas are associated with emotion recognition in people with Moebius syndrome. Although it does not appear that impairments in facial expression recognition accuracy are causing the social interaction problems found by Bogart and Matsumoto (in press) to occur with Moebius syndrome, if people with Moebius syndrome must use slower

compensatory mechanisms to recognize expressions, they may be slower to recognize and respond to social signals during interaction. However, other people's inability to recognize the emotions of people with Moebius syndrome is almost certainly a more important factor contributing to social interaction difficulty. Future studies should examine how others interpret the emotions of people with Moebius syndrome, and how the lack of facial mimicry in people with the condition affects social interaction.

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