The contribution of anterior and posterior regions of the right hemisphere to the recognition of emotional faces
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To investigate the contribution of posterior and anterior parts of the right hemisphere (RH) to emotional facial recognition, we studied 11 participants with anterior strokes of the right hemisphere (ASRH), 16 patients with posterior strokes of the right hemisphere (PSRH), and 31 normal controls. All individuals were right-handed and nondemented. The ability to recognize emotional facial expressions was assessed by using Ekman and Friesen’s (1976) Pictures of Facial Affect. Analysis revealed that both groups of patients presented with an impaired recognition of emotional faces. However, patients with PSRH were able to identify facial expressions better than participants with ASRH. In comparison to participants sustaining PSRH, patients with ASRH were particularly impaired on recognizing faces of negative valence. Thus, our results suggest that anterior parts of the RH seem to play an important role in the recognition of emotional facial expressions.

Keywords: Nonverbal communication; Facial affect; Cerebral infarction; Emotional perception impairment.

INTRODUCTION

The right hemisphere appears to be dominant in the recognition of emotional faces. Support for this postulate first came from observations of patients who had unilateral hemispheric brain injuries (Borod, Koff, Perlman Lorch, & Nicholas, 1986; Bowers, Blonder, Feinberg, & Heilman, 1991; DeKosky, Heilman, Bowers, & Valenstein, 1980; Kucharska-Pietura, 2006; Kucharska-Pietura, Phillips, Gernand, & David, 2003; Mandal et al., 1999; Schmitt, Hartje, & Willmes, 1997; Szelag & Fersten, 1991; Zgaljardic, Borod, & Sliwinski, 2002). Further support for this right-hemisphere dominance hypothesis came from visual half-field tachistoscopic and functional imaging studies (Davidson, Shackman, & Maxwell, 2004; Esslen, Pascual-Marqui, Hell, Kochi, & Lehmann, 2004; Lane, Reiman, Ahern, Schwartz, & Davidson, 1997; Murphy, Nimmo-Smith, & Lawrence, 2003; Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998; Wager, Phan, Liberonz, & Taylor, 2003). However, the role of different regions of the right hemisphere in facial recognition has not been entirely elucidated. Whereas visual-perceptual disorders, associated with brain injury, can induce emotional facial recognition disorders, the defective recognition of emotional faces in patients with right-hemisphere damage (RHD) cannot be accounted for solely by visual-perceptual deficits (Bowers, Bauer, Coslett, & Heilman, 1985; Bowers et al., 1991). Furthermore, Blonder and colleagues (Blonder, Bowers, & Heilman, 1991) demonstrated that the impaired recognition of emotional facial expressions associated with RHD is not limited to visual percepts and is also...
not directly related to higher order semantic-conceptual deficits.

There are at least two major reasons why RHD might impair the recognition of emotional faces. First, the recognition of emotional faces might depend on the ability to access emotional facial representations. Second, Moody and coworkers (Moody, McIntosh, Mann, & Weisser, 2007) demonstrated that the presentation of emotional faces induced facial emotional expressions, possibly by inducing experiences. Recognition of emotional faces might, at least in part, also be dependent on emotional expressions or experiences or both. In regard to the role of emotional experiences, it has been hypothesized that the frontal lobes, particularly in right hemisphere, mediate processes associated with avoidance behaviors, while posterior regions are involved in approach behaviors (Denny-Brown & Chambers, 1958; see also Heilman, Blonder, Bowers, & Crucian, 2000). Denny-Brown and Chambers (1958) also suggested that approach and avoidance behaviors may be reciprocal such that a loss of one behavior may release the other behavior. Those observations, together with the fact that negative emotions are often associated with avoidance behaviors and positive with approach behaviors, find some support in behavioral studies (for review, see Heilman, Blonder, Bowers, & Valenstein, 2003; Robinson, 1998). For example, it has been shown that after RHD (in its acute phase) depression typically occurs in patients with posterior cortical lesions (House, Dennis, Warlow, Hawton, & Molyneux, 1990), whereas several clinicians noted that patients with right frontal lesion often show inappropriate indifference to negative stimuli or inappropriate euphoria (Babinski, 1914; Denny-Brown, Meyer, & Horenstein, 1952; Hecaen, Ajuriagurra, & de Massonnet, 1951; Robinson, Bolduc, & Price, 1987) as well as inappropriate jocularity (“Witzelsucht”) or moria (Oppenheim, 1889; Jastrowitz, 1888).

Despite some data implying frequent occurrence of depressive symptoms after posterior RHD, it has been repeatedly reported that depression is predominantly seen in patients suffering from anterior left-hemisphere lesions (Benson, 1973; Gainotti, 1972; Goldstein, 1948; Robinson, 1998), and it has been suggested that approach versus avoidance behaviors might be related to frontal hemispheric asymmetries in mediating emotional valence (Davidson, 1984; Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Fox et al., 1995; Kinsbourne, 1982). Based on this dichotomy, approach behaviors have been suggested to be normally mediated by the left frontal lobe and avoidance behaviors by the right frontal regions.

The frontal lobes also have multiple connections with limbic structures that subserve emotional processes. Thus, the networks that mediate mood and emotional experiences might be highly interactive and integrated with those that are important for the recognition-perception of certain forms of emotion, and right frontal injury might degrade these complex networks, leading particularly to the impaired recognition of faces expressing negative emotions.

It is also possible that the recognition of facial expressions might be processed by separate or independent neural systems from those important in mediating emotional experiences, and the output of these recognition systems might converge and interact with those systems important in producing emotional experiences (Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). This separate recognition system, however, might be dependent on stored representations of emotional faces.

There are at least two possible, but not mutually exclusive, means by which these emotional facial representations might be stored. First, they can be stored iconically, such that when a normal person sees an emotional face, recognition of this emotion is accomplished by activation of a prototypical emotional facial iconic representation. Second, since immediately after seeing an emotional facial expression people typically emote that expression, perhaps by using mirror neurons (McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006; Moody et al., 2007), it is possible that the emotional facial representation may be stored motorically, and recognition of these emotional expressions might require covert mimicry (mirror system) with access to stored emotional facial movement-postural representations. Thus, to perceive emotional faces, a person might have to access movement-posture representations that are stored in the right frontal lobe.

Patients with Parkinson’s disease (PD) often have immobile or mask-like faces and rarely spontaneously express facial emotions. Thus, when seeing an emotional face they might fail to mirror-mimic these facial expressions and activate the motor representations important for recognition. Jacobs and coworkers (Jacobs, Shuren, Bowers, & Heilman, 1995) studied subjects with PD and found that they were impaired in recognizing emotional faces. This study also revealed a significant correlation between both the emotional recognition and expression tasks. Based on these findings, Jacobs and coworkers suggested that the basal ganglia-frontal networks (for review, see Alexander, DeLong, & Strick, 1986) of the right hemisphere are part of a neural network subserving emotional facial expression...
and comprehension. This postulate finds support in recent activation studies showing that the highest brain activation during the recognition of emotional facial expressions is often found in the right frontal areas (Esslen et al., 2004).

There is, however, also evidence to suggest that posterior regions of the right hemisphere may play an important role in the process of facial affect recognition. Based on clinical observations as well as experimental findings, Ross and coworkers (Ross, 1981; Ross & Monnot, 2008) suggested that the organization of emotional processes within the right hemisphere mirrors the organization of propositional language in the left hemisphere. Thus, right posterior regions would be specifically implemented in emotional perception. Additionally, since in the left hemisphere the supramarginal gyrus appears to contain programs for transitive movements (Heilman & Rothi, 2003), perhaps the right supramarginal gyrus stores the movement representations of facial emotions, and the right somatosensory area is important for perceiving self-generated emotional expressions.

If the recognition of emotional faces relies on covert mimicry and access to facial movement representation, then the anterior portions of the right hemisphere’s cerebral cortex would be critical for the recognition of emotional faces. If, in contrast, recognition of emotional faces relies on access to visual iconic representations, then injury to posterior portion of the right hemisphere would be more likely to impair the recognition of emotional faces. Although a recent neuroimaging study by Esslen and coworkers (2004) suggests that the right frontal areas seem to be important in the recognition of emotional facial expressions, some of the lesion studies did not find any relationship between lesion site within the right hemisphere and impaired facial affect recognition (Mandal et al., 1999), and, as mentioned, others found posterior lesion sites (Adolphs, Damasio, Tranel, Cooper, & Damasio, 2000). In light of these discrepancies, the purpose of the present study was to investigate the contribution of the anterior and posterior regions of the right hemisphere to the recognition of emotional facial expressions.

**METHOD**

**Participants**

A total of 11 patients with anterior strokes of the right hemisphere (ASRH), 16 patients with posterior strokes of the right hemisphere (PSRH), and 31 demographically matched normal controls (NC) were the participants for this study. All participants were right-handed and were recruited from the Department of Neurology at the Medical University of Gdansk and from the Hospital of the Gdansk Rehabilitation Center in Dzierzazno. In all participants handedness was identified based on the interview where participants declared their own hand preference. Patients with ASRH as well as patients with PSRH had infarctions limited only to the right hemisphere. Based on previous reports (for review, see Robinson, 1998), anterior lesions were defined as lesions in which the rostral border was less than 40% of the overall anterior-posterior length of the brain on computed tomography (CT) or magnetic resonance imaging (MRI) scan, and posterior lesions were defined as lesions in which the rostral border was located at more than 40% of the anterior-posterior dimension. The location of our experimental participants’ brain injuries are listed in Table 1. Cortical lesions were defined as ischemic damage limited to the cerebral cortical gray matter or/and underlying white matter. Subcortical lesions were defined as infarcts that injured any of the following areas: basal ganglia, thalamus, amygdala, or white matter of the internal capsule.

Before testing, informed consent was obtained from each study participant. In addition to CT and/or MRI, the ASRH and PSRH participants underwent a complete neurological evaluation. None of the participants had a history of cerebral disease or disorder prior to their stroke, and none had mental retardation, psychiatric disorders, psychoactive drug treatment, or habitual drug or alcohol abuse. The presence or absence of the exclusionary criteria was determined by interviewing both patients and relatives as well as by reviewing the participants’ medical records. Most of the RHD patients were examined about 9 months following their stroke (the mean time from the onset for

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Lesion location for patients with anterior or posterior lesions of the right hemisphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>Right-hemisphere lesion site</td>
</tr>
<tr>
<td>ASRH</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>frontal</td>
</tr>
<tr>
<td></td>
<td>fronto-temporal</td>
</tr>
<tr>
<td></td>
<td>subcortical</td>
</tr>
<tr>
<td>PSRH</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>temporo-parietal</td>
</tr>
<tr>
<td></td>
<td>temporo-occipital</td>
</tr>
<tr>
<td></td>
<td>parieto-occipital</td>
</tr>
<tr>
<td></td>
<td>parietal</td>
</tr>
<tr>
<td></td>
<td>subcortical</td>
</tr>
</tbody>
</table>

Note. ASRH = anterior strokes of the right hemisphere. PSRH = posterior strokes of the right hemisphere.
ASRHs and PSRHs was, respectively, 265 days; $SD = 135.33$, and 287 days; $SD = 113.85$). A total of 8 of the 11 ASRHs and 15 of the 16 patients with PSRH had a left hemiparesis, whereas the 4 remaining patients had no physical impairment. None of the patients with RHD, regardless of lesion locations, had speech comprehension deficits or other aphasic disorders, but 3 out of the 11 patients with ASRH as well as 9 out of the 16 patients with PSRH did have evidence of hemispatial neglect, as assessed by the Mesulam Cancellation Test (Lezak, 1995). Statistical analyses revealed no significant group differences for sex, age, and years of education. The cognitive state of all participants was assessed by the Mini Mental State Examination (MMSE), and the results of this examination did not differ between groups. Means and standard deviations ($SD$s) for demographics as well as for MMSE are listed in Table 2. To exclude participants with prosopagnosia and severe visual perceptual disorders the participants were asked to identify two additional neutral faces of well-known, prominent people. None of the participants included in this study demonstrated a failure to identify these faces. Participants who had clinically relevant visual or hearing difficulties were not included. All individuals were native speakers of Polish. NCs were examined in the same way as the experimental participants with strokes. They had no history of neurological disease and were referred to the rehabilitation center only because they had physical disabilities related to disorders of the peripheral nervous system.

Of the 27 experimental participants included in this research study 21 with RHD as well as all 31 NCs were also participants in our previous study (Harciarek, Heilman, & Jodzio, 2006). Overall, that project revealed that the representations needed to recognize emotional stimuli are organized by modality (prosodic-echoic; facial-eidetic) and that some modality-specific features are more impaired than others. However, in this previous study, we used only three types of visually presented emotions (happiness, sadness, anger) derived from Pictures of Facial Affect by Ekman and Friesen (1976), and we did not investigate the potentially differential role of the anterior and posterior regions of the right hemisphere in the recognition of emotional faces.

### Apparatus and procedure

The ability to recognize facial emotions was assessed by presenting participants with 25 black-and-white pictures of human faces selected from Pictures of Facial Affect by Ekman and Friesen (1976). Those pictures selected and used in our study had the highest Cronbach’s alpha coefficients (i.e., most reliable; median = .94), based on the data published by Ekman and Friesen (1976) and using the procedure proposed by Hull and Nie (1981). Each of these photographs expressed one of Ekman and Friesen (1976) basic emotions, including sadness (5 pictures), happiness (5 pictures), anger (5 pictures), fear (5 pictures), and disgust (5 pictures). The sixth basic emotion proposed by these authors is surprise, but surprise has been often characterized as a brief state rather than a true emotion, and this state is often rapidly followed by other emotions such as happiness or fear (Ekman & Davidson, 1994). Therefore, in light of this controversy, we decided not to include pictures of faces expressing surprise. The order in which these emotions were presented was randomized, but the pictures were presented in the same order to all 58 participants. There was no time limit for the stimulus exposure, and each trial ended after the participant responded. Participants named or pointed to the answer they thought was correct using a $21 \times 27$-cm response card. In order to control for possible unilateral neglect, the card was centrally placed with all five emotions listed.

### TABLE 2

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ASRH (n = 11)</th>
<th>PSRH (n = 16)</th>
<th>NC (n = 31)</th>
<th>Test value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (no. male/female)</td>
<td>5/6</td>
<td>9/7</td>
<td>14/17</td>
<td>$\chi^2 = 0.55$</td>
<td>.76</td>
</tr>
<tr>
<td>Age (years)</td>
<td>65.00 (11.97)</td>
<td>62.94 (8.46)</td>
<td>63.77 (9.06)</td>
<td>$F = 0.15$</td>
<td>.86</td>
</tr>
<tr>
<td>Years of education</td>
<td>10.45 (4.01)</td>
<td>10.19 (4.00)</td>
<td>10.42 (1.94)</td>
<td>$F = 0.04$</td>
<td>.96</td>
</tr>
<tr>
<td>Days since stroke</td>
<td>265.36 (133.33)</td>
<td>287.19 (113.85)</td>
<td>—</td>
<td>$t = -0.25$</td>
<td>.80</td>
</tr>
<tr>
<td>MMSE</td>
<td>27.64 (2.25)</td>
<td>26.56 (2.53)</td>
<td>27.71 (1.57)</td>
<td>$F = 1.84$</td>
<td>.17</td>
</tr>
<tr>
<td>Left hemiparesis</td>
<td>8</td>
<td>15</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Hemispatial neglect</td>
<td>3</td>
<td>9</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*Note. ASRH = anterior strokes of the right hemisphere. PSRH = posterior strokes of the right hemisphere. NC = normal controls. MMSE = Mini-Mental State Examination. Mean values shown, with standard deviations in parentheses.*
vertical. Participants received one point for each correctly recognized emotional face. However, in addition to the total score in this task (representing a sum of all points), subscores for the correct recognition of each type of emotion were also recorded. This procedure enabled us not only to assess the difference between the overall ability of patients with ASRH and PSRH to recognize emotional faces, but also to compare their ability to recognize each type of five basic emotions. This procedure also allowed us to assess a possible intraindividual variability in recognizing the different types of emotional facial expressions.

**ANALYSIS AND RESULTS**

Most of dependent variables collected in this study were not normally distributed and could not be transformed. Thus, nonparametric tests of significance were used to carry out both the between-group and the within-group comparisons.

The scores obtained by ASRH and PSRH patients as well as by NCs on the emotional facial task were compared using the Kruskal–Wallis Test. This analysis revealed significant group differences (see Table 3). Post hoc comparisons using the Mann–Whitney test showed that ASRH participants’ total score for the facial recognition task was significantly lower than that obtained by PSRHs ($z = -3.73, p < .001$) and NC participants ($z = -4.96, p < .001$). The PSRH participants’ total score was also lower than that obtained by NCs ($z = -5.38, p < .001$).

To learn whether there are any group differences in the ability to recognize specific type of emotion (e.g., fear), we used the Mann–Whitney test to compare these emotion-specific subscores obtained by the three participant groups: ASRHs, PSRHs, and NCs. The results of the analyses showed that, in contrast to patients with PSRH, those with ASRH had increased difficulties with the recognition of sadness ($z = -2.77, p < .01$), anger ($z = -2.21, p < .05$), disgust ($z = -1.93, p < .06$—a trend towards statistical significance), and fear ($z = -2.25, p < .05$). Similar but more significant discrepancies between ASRH patients and NCs as well as between PSRHs and NCs were observed for the recognition of each emotion with negative valance ($p < .001$). In contrast, there was no statistically significant difference between the ASRH and PSRH groups ($z = -1.78, p = .08$) or between PSRH and NC groups ($z = -0.36, p = .72$) on the recognition of happy faces. However, the ASRH participants correctly identified a lower number of happy faces than did NCs ($z = -2.68, p < .01$).

Some prior studies have demonstrated that some emotional faces are more easy to recognize than others and that there might be category-specific emotional deficits in some patients with brain damage (Kucharska-Pietura et al., 2003; Mandal et al., 1999). Thus, we wanted to determine whether there were any within-group differences in the recognition of specific subtypes of visually presented emotions. Hence, within-group differences between correctly identified specific emotions were assessed using the Friedman test, and post hoc testing was done using the Wilcoxon signed ranks test.

In the ASRH group, statistical analysis revealed a significant difference in the recognition of different categories of emotional facial expressions ($\chi^2 = 15.05, p < .01$). Post hoc comparisons showed that, in the ASRH group, happiness was better recognized than the facial expression of sadness ($z = -2.83, p < .01$), anger ($z = -2.55, p < .05$), disgust ($z = -2.37, p < .05$), and fear ($z = -2.46, p < .05$). Within the ASRH group, however, there were no statistically significant differences in the number of correct responses between the different emotional expressions that have a negative valance. In addition, differences between the correct number of visually

<table>
<thead>
<tr>
<th>Variables</th>
<th>ASRH</th>
<th>PSRH</th>
<th>NC</th>
<th>Kruskal–Wallis test, $\chi^2$</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score</td>
<td>11.82 (2.86)</td>
<td>16.94 (2.41)</td>
<td>22.48 (1.15)</td>
<td>44.33**</td>
<td>ASRH &lt; PSRH &lt; NC</td>
</tr>
<tr>
<td>Happiness</td>
<td>4.09 (1.51)</td>
<td>4.63 (1.26)</td>
<td>4.90 (0.30)</td>
<td>7.82*</td>
<td>ASRH &lt; PSRH</td>
</tr>
<tr>
<td>Sadness</td>
<td>1.91 (0.94)</td>
<td>3.25 (1.18)</td>
<td>4.68 (0.60)</td>
<td>35.18**</td>
<td>ASRH &lt; PSRH &lt; NC</td>
</tr>
<tr>
<td>Anger</td>
<td>1.82 (1.33)</td>
<td>2.94 (0.85)</td>
<td>4.45 (0.62)</td>
<td>35.62**</td>
<td>ASRH &lt; PSRH &lt; NC</td>
</tr>
<tr>
<td>Disgust</td>
<td>2.18 (1.33)</td>
<td>3.25 (1.12)</td>
<td>4.55 (0.72)</td>
<td>27.62**</td>
<td>ASRH &lt; PSRH &lt; NC</td>
</tr>
<tr>
<td>Fear</td>
<td>1.82 (1.25)</td>
<td>2.88 (0.88)</td>
<td>3.90 (0.94)</td>
<td>22.22**</td>
<td>ASRH &lt; PSRH &lt; NC</td>
</tr>
</tbody>
</table>

*Note. ASRH = anterior strokes of the right hemisphere. PSRH = posterior strokes of the right hemisphere. NC = normal controls. Mean values shown, with standard deviations in parentheses. *$p < .01$. **$p < .001$. 
presented emotions were also found in the PSRH group ($\chi^2 = 26.01, p < .001$) as well as in the NC group ($\chi^2 = 28.38, p < .001$; see Figure 1). The participants with PSRH, like those with ASRH, had less difficulty recognizing the facial expression of happiness than the facial expression of sadness ($z = -2.58, p < .01$), anger ($z = -2.89, p < .01$), disgust ($z = -2.85, p < .01$), or fear ($z = -2.45, p < .05$). The participants with PSRH also had no differences between the number of correctly identified specific types of negative emotions. Furthermore, post hoc testing revealed that, among the control participants, happy faces tended to be also significantly better identified than the facial expressions of sadness ($z = -1.93, p < .06$), and happiness was significantly better recognized than anger ($z = -3.12, p < .01$), disgust ($z = -3.88, p < .001$), or fear ($z = -2.49, p < .05$). Of the different negative emotional faces, the NCs had a significantly greater difficulty with recognizing faces expressing fear than the other faces expressing sadness ($z = -3.06, p < .01$), anger ($z = -2.19, p < .05$), or disgust ($z = -2.34, p < .05$).

Some of the RHD experimental participants had neglect, and some had a hemiparesis. Therefore, we wanted to learn whether there was any relationship between these neurological deficits and their ability to recognize emotional facial expressions. A Spearman rank correlation analysis did not reveal a significant relationship between the number of correctly recognized emotional faces and the presence of hemispatial neglect ($\rho = .19, ns$) nor hemiparesis ($\rho = .11, ns$).

Additionally, to further control for hemispatial neglect, we used the Mann–Whitney test to compare the performance on facial affect task between RHD patients who demonstrated or did not demonstrate neglect, independent of their lesion location. We found no statistically significant difference between these groups ($z = -0.98, ns$).

DISCUSSION

This study was designed to better understand the role of the anterior and posterior regions of the right hemisphere in the process of the recognizing facial emotional expressions. In general, the results confirm previous research showing that the RHD, regardless of lesion location, leads to an impairment in recognizing emotional faces (Borod et al., 1986; Bowers et al., 1991; DeKosky et al., 1980; Kucharska-Pietura et al., 2003; Mandal et al., 1999; Szeg & Fersten, 1991; Zgaljardic et al., 2002; for review, see also Borod, 1992; Heilman et al., 2003). However, the patients with ASRH, in comparison to individuals with PSRH, were more impaired at recognizing emotional facial expressions, providing further support for the postulate that the anterior regions of the right hemisphere are important for the correct recognition of emotional facial expressions (Cancelliere & Kertesz, 1990; Esslen et al., 2004; Jacobs et al., 1995; Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998).

The reason why our patients with ASRH were more impaired on recognizing emotional faces than were individuals with PSRH is not entirely known. Nonetheless, based on the observations by Jacobs and colleagues (1995), it is possible that the severe deficits seen in this ASRH group might be attributed to an inability of facial emotional percepts to gain access to and activate facial emotive programs that might be then converted to sensory percepts by the somatosensory cortex. Partial support for this postulate comes from a study by Adolphs and coworkers (2000), who found that the activation of the somatosensory cortex is crucial for the recognition of facial affect.

Although patients with PSRH had less difficulty recognizing visually presented emotional faces than did patients with ASRH, when the PSRH group was compared to NCs, the performance of patients with PSRH on the facial affect recognition task was significantly impaired. This finding suggests that the recognition of facial emotional expressions might require accessing visual iconic representations stored in the more posterior regions of the right hemisphere (Heilman et al., 2003). This activation might be direct from the visual pathways or indirect by means of somatosensory cortex. Thus, both the anterior and posterior regions of the right hemisphere might be portions of a facial-emotional neuronal network that is critical for the recognition of facial emotional expressions. In addition to recognizing emotional facial expressions by mimicry and activating iconic representations, there is evidence that portions of the limbic system, such as the amygdala, might also play a role in the facial emotional recognition of emotional faces and the presence of hemispatial neglect ($\rho = .19, ns$) nor hemiparesis ($\rho = .11, ns$).
recognition. Some facial emotional expressions, such as fear or anger, can activate limbic structures, such as the amygdala, and this activation might induce an emotional experience that aids recognition. Accordingly to Bauer (1982, 1984), lesions to the right dorsal visual stream may disconnect visual and somatosensory cortex from limbic structures, like the amygdala, and such a disconnection might also explain why our patients with PSRH were impaired at recognizing facial emotional expressions.

Our findings suggesting that anterior regions of the right hemisphere might be associated with impaired facial affect recognition are somewhat consistent with the theory suggesting that the organization of emotional processes within the right hemisphere mirrors the organization of propositional language in the left hemisphere (Ross, 1981; Ross & Monnot, 2008). However, in the present study, not only lesions to anterior regions but also damage to posteriorly located brain regions impaired the correct recognition of facial affect. Thus, this finding indicates that posterior regions of the right hemisphere might be, indeed, involved in emotional perception. In addition, since in the present study 36% of patients with ASRH had subcortical lesions, it is possible that the greater impairment of participants with ASRH seen in the present study might have resulted from a specific bias due to the fact that over one third of patients with ASRH might have had lesions involving amygdala and/or basal ganglia, structures that have been shown to be particularly important for facial affect recognition (Adolphs, Tranel, Damasio, & Damasio, 1994; Cancelliere & Kertesz, 1990).

The goal of this study was to learn whether anterior versus posterior injury of the right hemisphere impaired emotional facial recognition and not to test the anatomic basis of the emotional “valence” hypothesis (Reuter-Lorenz & Davidson, 1981). We did, however, note that all three groups of participants were most accurate in identifying a positive emotion (happiness) than negative emotions (anger, sadness, fear, and disgust). These results support prior research suggesting that both NCs and patients with RHD have less difficulty recognizing facial expression of happiness than recognizing negative facial expressions (Kucharska-Pietura et al., 2003; Mandal et al., 1999). Since this finding was also reported and discussed in one of our recently published papers (Harciarek et al., 2006), we do not reiterate an in-depth review of the possible explanations for these observations. However, apart from the multiple neuropsychological, developmental, and social reasons why happy faces may be easier to recognize than faces expressing negative emotions, this dissociation might be related to differences in discriminative visual complexity of these stimuli. This hypothesis was supported by Young and colleagues (1997) who, using Ekman and Friesen (1976) pictures of emotional faces, found that the pictures of happy faces were the easiest to recognize. Although happy facial expressions might be easier for people to perceive, when our participants with ASRH were compared to the NCs, their ability to correctly recognize happy faces was also impaired, suggesting that the anterior regions of the right hemisphere do play a role even in the recognition of happy faces.

Since we did not test patients with left-hemisphere damage (LHD), particularly those with strokes in the anterior regions of the left hemisphere, we were not able to fully assess the hemispheric approach–avoidance hypothesis of emotion (Davidson, 1984; Davidson et al., 1990; Fox et al., 1995; Kinsbourne, 1982) and its influence on the recognition of facial emotional expressions. The results of this study, however, suggest that the frontal regions of the right hemisphere do not seem to play a special role in the recognition of emotional facial expressions normally associated with avoidance behaviors, such as disgust or fear. In addition, the posterior regions of the right hemisphere do not appear to be specifically involved in the recognition of emotional facial expressions that are normally associated with approach behaviors (e.g., happiness). Therefore, the posterior–anterior neural organization of approach–avoidance emotional behaviors, formed primarily on studies of emotional experience, do not appear to apply to the recognition of facial affects.

This study has several limitations. First, although all participants had a normal MMSE and did not have prosopagnosia, and there was no relationship between scores on emotional recognition task and hemispatial neglect, we cannot fully rule out the possibility that subtle perceptual/cognitive deficits might have contributed, at least in part, to our participants’ impaired performance on this facial emotion recognition task. Second, despite using pictures that had the highest reliability from all the stimuli derived from the Ekman’s series, when testing recognition of specific emotions we only used five trials. This low number of test items might have reduced reliability and, thus, hampered within-group comparisons. Therefore, future studies assessing facial emotional recognition might benefit from using a greater number of emotional stimuli. Third, although there is overwhelming evidence that it is damage to the right hemisphere that impairs the recognition of emotional faces (Borod et al., 1986; Bowers et al., 1991; DeKosky et al., 1980; Kucharska-Pietura, 2006; Kucharska-Pietura et al., 2003; Mandal et al., 1999; Schmitt et al.,
Bauer, R. M. (1982). Visual impairment of patients with ASRH seen in our study is specific to right-hemisphere injury. In addition, without an LHD control group we could not directly test the approach–avoidance hypothesis (Davidson, 1984; Davidson et al., 1990; Fox et al., 1995; Kinsbourne, 1982). Fourth, we did not have sufficient neuroimaging data to assess the role of the injury to specific anatomic areas (e.g., amygdala), and future studies might also want to assess the role of various lesion sites. Prior studies have not shown a significant correlation between the lesion size and the accuracy of emotional perception (Mandal et al., 1999). However, in this study we were unable to determine whether lesion size influenced our results. Therefore, although this study clearly suggests that anterior parts of right hemisphere play an important role in the recognition of facial affect, additional research is needed to test the motor facial-emotion representation hypothesis, to determine the specific regions of the right hemisphere involved in the processing of facial emotional expressions, and to learn whether lesion size influences recognition.

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