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Perceived Stress and Depression in Left and Right Hemisphere Post-Stroke Patients

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Abstract

Background and Purpose—Although it is well accepted that depression and stress are closely related in the general adult population, this link is less understood in post-stroke patients. Due to the high occurrence of depression in post-stroke patients it is important to look closely at this possible association. The current study explores perceived stress and depression in post-stroke patients.

Methods—Nineteen left hemisphere (LH) stroke patients and 12 right hemisphere (RH) post-stroke patients were assessed for depression, perceived stress, and neurological functioning with the *Stroke Aphasia Depression Questionnaire*, the *Perceived Stress Scale*, and the *Scandinavian Stroke Scale* once per month for three months.

Results—Perceived stress and depressive symptoms were significantly correlated for both stroke groups. Neurological functioning was not correlated with either depressive symptoms or perceived stress in either stroke group.

Conclusion—The perception of stress may be a more critical variable in developing post-stroke depression than neurological functioning is in stroke patients. Routine screening of perception of stress may need to occur in post-stroke patients to avoid development of depression.

Keywords

stroke; perceived stress; depression; neurological functioning; aphasia

Post-stroke depression (PSD) appears to be a controversial issue as the prevalence, incidence, diagnosis, and cause remain undetermined despite considerable research (Paolucci, 2008). A recent meta-analysis and review of the literature indicates that approximately one third of stroke patients experience depression (Ayerbe, Ayis, Wolfe, & Rudd, 2013; Hackett, Yapa, Parag, & Anderson, 2005), although, this percentage appears to be affected by time post-onset (Kouwenhoven, Kirkevold, Engedal, & Kim, 2011). Much effort has focused on the organic link between site of neurologic lesion and depressive symptoms as a route to better understand the cause of PSD (e.g., Spalletta et al., 2006). However, this link between lesion and symptoms may be complicated by the presence or degree of cognitive and physical impairments, sex, and, family history of depression (Berg, Palomäki, Lehtihalmes, Lönnqvist, & Kaste, 2003; Hackett et al., 2005; Hilari et al., 2010; Kauhanen et al., 2000; Kellermann et al., 1999; Nys et al., 2006). Although many risk factors for developing PSD have been considered, perceived stress has been largely ignored

as a contributor to PSD (with the exception of Ostwald, Swank, & Khan, 2008). In the general adult population, it is well accepted that depression and stress are closely related (Bao, Meynen, & Swaab, 2008; Caspi et al., 2003; Kendler, Karkowski, & Prescott, 1999; Papp, Moryl, & Willner, 1996; Paykel & Dowlathshahi, 1988). Certainly, depression can be considered a response to stress. Although stressful life events in and of themselves have been identified as precursors to depression (Brown & Harris, 1978; Chatterjee, Mukherjee, & Nandi, 1981; Kendler et al., 1999), an individual's *perception* of stress appears to be an important variable affecting the development of depression. Indeed, Hewitt, Flett, and Mosher (1992) demonstrated that perceived stress is predictive of depression; in their clinical sample of depressed patients, greater perceived stress was associated with more severe depression. Perceived stress has been conceptualized as an outcome related to the experienced level of stress as a function of objective stressful events, appraisal of the stressor, and utilization of coping resources (S. Cohen, Kamarck, & Mermelstein, 1983; Lazarus & Folkman, 1984), thus making it highly susceptible to individual differences.

Previously, Laures-Gore, Hamilton, & Matheny (2007) found left hemisphere post-stroke patients living with aphasia demonstrate greater perceived stress than adults without stroke. Aphasia in and of itself may be a stressor in addition to other concomitant stroke related impairments. Unfortunately, most studies of PSD exclude adults living with aphasia (Kouwenhoven et al., 2011); thus, an understanding of the contribution of aphasia to PSD is limited. Only a handful of studies have included patients with aphasia in their sample with mixed results as to the effect of aphasia on developing PSD (Berg et al., 2003; Kauhanen et al., 2000; Kellermann et al., 1999; Nys et al., 2005). Relatedly, stroke severity and neurological impairment including hemiparesis have been associated with depression (Fatoye et al., 2009; Vataja et al., 2001).

Although communication and other neurological impairments are important variables to consider in the diagnosis of PSD, it may be more important to focus on the perception of stress. Differences in perceptions of stress among stroke patients may contribute to the high degree of individual variation observed in stress responses (Laures-Gore, 2012) that may result in PSD. A greater understanding of perceived stress and its link to PSD may aid in the diagnosis of PSD and the development of more focused medical and psychosocial treatments.

The purpose of the current study is to determine whether perceived stress and depressive symptoms are associated in a sample of left hemisphere (LH) and right hemisphere (RH) stroke patients. Additionally, we sought to investigate the relation of perceived stress and depressive symptoms to neurological functioning (including presence or absence of aphasia) in both groups as a way to determine whether the perception of stress and depression are tied to the degree of stroke-related impairment. Due to the individual nature of stress perception (as defined earlier) it may be that the degree of neurological impairment is not as crucial as one's perception of it as a stressor. Because there is indication that PSD changes over time with it lessening the further post-onset (Hackett et al., 2005; Kouwenhoven et al., 2011), we sought to examine whether depression, neurological functioning, and perceived stress change over time in both stroke groups. The inclusion of two stroke groups permits an additional level of analysis which allows for consideration of hemisphericity as a variable in perceived stress and depression.

Methods

Participants

Participants were recruited by word of mouth from area speech-language pathology departments and have been described in detail earlier by Laures-Gore (2012). Nineteen LH

(8 males, 11 females) and 12 RH (8 males, 4 females) participants were included in the current study. Location of stroke site was confirmed by neuroimaging reports. The LH group's mean age was 55.7 years ($SD = 9.1$), and the RH group's mean age was 58.5 years ($SD = 8.4$). Enrollment in the study began between 1–6 months post onset of their stroke. This time period allowed for inclusion of participants who were beyond the acute stage of post-stroke recovery. Participants were excluded from the study if they had multiple strokes, bilateral strokes, head injury, or were outside of the age range of 40–75 years. Mean initiation of study was 2.4 months post onset ($SD = 1.3$ months) for LH and 2.4 months post onset ($SD = 1.6$ months) for the RH group. All participants passed a hearing screening at .5, 1, and 2 KHz at 45 dB bilaterally and a vision screening (20/40 corrected vision). During the screening procedure, two participants (one LH, one RH) reported a medical diagnosis of depression following their strokes. One additional participant (RH) reported a pre-stroke diagnosis of depression.

Measures and Procedure

All participants were involved in four testing sessions over the course of three months (0, 4, 8, 12 weeks after initiation of the study). Mean time between testing administrations was 30 days ($SD = 3.23$ days) for the LH group and 29.8 days ($SD = 4.32$ days) for the RH group. Sessions were conducted either at the participant's home or on the campus of Georgia State University.

At the initial testing session, all LH participants were assessed for aphasia via the *Western Aphasia Battery-Aphasia Quotient* (WAB-AQ; Kertesz, 1982). All RH participants were given the *Mini Inventory of Right Brain Injury-2* (MIRBI-2; Pimental & Knight, 2000) to assess the presence of cognitive-communication disorder, as well as the WAB-AQ to rule out the presence of aphasia. Participants were not excluded based on severity of impairment.

During each of the four testing sessions, all participants in both groups were assessed for stress (*Perceived Stress Scale*; S. Cohen et al., 1983), depression (*Community Stroke Aphasic Depression Questionnaire-10*; Sutcliffe & Lincoln, 1998), and neurological functioning (*Scandinavian Stroke Scale*; Scandinavian Stroke Study Group, 1985).

Western Aphasia Battery-Aphasia Quotient (WAB-AQ)—Presence of aphasia was determined by the WAB-AQ, a composite score indicating aphasia severity. This score is composed of subtest scores for spontaneous speech, auditory comprehension, repetition, naming and word finding skills. Scores are categorized according to severity and aphasia type.

Mini Inventory of Right Brain Injury-2 (MIRBI-2)—The MIRBI-2 assesses cognitive-communication deficits typically associated with right hemisphere damage (e.g., visuospatial skills, affective processing, and abstract language interpretation). Stanine scores indicate overall severity rating.

Perceived Stress Scale (PSS)—This 10-item scale measures the extent to which participants perceive situations in their lives as stressful. For different stress-related thoughts and emotions (e.g., feeling out of control, unable to cope), participants are asked to rate the frequency of occurrence over the last month (0 = Never, 4 = Very Often). Higher scores indicate higher levels of perceived stress. The PSS is a widely-used measure with established validity and reliability across a variety of clinical and non-clinical populations (e.g., Hewitt et al., 1992; Roberti, Harrington, & Storch, 2006). Either the first author or a caregiver/friend/spouse read the questions aloud while the participants read along. Answers were selected by the participant and recorded by the individual reading the questions.

Stroke Aphasic Depression Questionnaire-10 (SADQ-10)—This 10-item observer-rated questionnaire was developed specifically to assess depressed mood in individuals with aphasia. Observers are asked to rate ten different depression-associated behaviors (e.g., crying, displays of anger, restlessness) according to frequency (0 = Never, 3 = Often), with higher scores indicating lower mood. While the majority of available depression assessments are based on self-report, observer report may be a more feasible method of assessment in individuals with language impairments. The assessment was developed with a sample of stroke patients with aphasia (Sutcliffe & Lincoln, 1998). It was later validated in a sample of stroke patients without aphasia by correlating *SADQ* scores with traditional self-report depression questionnaires such as the *Geriatric Depression Scale* (Leeds, Meara, & Hobson, 2004) and the *Hospital Anxiety and Depression Scale* (Sackley, Hoppitt, & Cardoso, 2006). A subsequent study examining the use of the *SADQ-10* in patients without aphasia established a cut-off score of 14/30 (70% sensitivity and 77% specificity) to indicate clinically significant depression symptoms (Leeds et al., 2004). The *SADQ-10* was completed by the participant's caregiver/friend/spouse.

Scandinavian Stroke Scale (SSS)—The Long-Term score (*SSS-LT*) was used to assess neurological functioning at each assessment time. The *SSS-LT* evaluates motor power in the upper and lower extremities, orientation, speech, facial palsy, and gait. The rater assigns point values to each of these areas, with lower scores indicating more severe impairments. This measure has established inter-rater reliability (weighted kappa 0.688 to 0.912) (Lindenstrøm, Boysen, Waage Christiansen, & Würtzen Nielsen, 1991). The first author rated the *SSS-LT* for all participants.

Data Analyses

Pearson's correlation analysis was conducted to explore the relations between scores on the *PSS*, *SADQ-10*, and the *SSS*. Independent samples t-tests were used to examine differences in scores between LH and RH stroke groups. Mixed-design analyses of variance (ANOVAs) were performed on each of the three measures to detect patterns of change over time by group; effect sizes were calculated with partial η^2 (J. Cohen, 1973). Analyses were completed with SPSS (v. 20) with alpha set at .05.

Results

No significant differences were found between LH and RH groups in age of participants ($t = -.86, p = .77$) or months post onset at study enrollment ($t = .11, p = .83$). At the initiation of the study, all LH participants had aphasia (Mean *WAB-AQ* of 57.8, $SD = 29.3$). No RH participants had aphasia as defined by a *WAB-AQ* score lower than 93.8. However, they did have mild-moderate cognitive-communication disorders (Mean *MIRBI* = 5.7, $SD = 1.2$).

To determine the association between degree of neurological impairment, perceived stress, and depression, means for each of the three corresponding measures (*SSS*, *PSS*, and *SADQ*) were calculated (averaging across the four test administrations). These means and standard deviations are presented in Table 1. Pearson's correlations were conducted on the means of each of the three measures for the entire sample. Overall, there was a strong positive correlation between *PSS* and *SADQ* scores ($r(30) = .62, p < .001$), suggesting that across participants, higher perceived stress is associated with more severe depressive symptoms. However, no associations between neurological impairment (*SSS*) and either *PSS* ($r(31) = -.02, p > .20$) or *SADQ* ($r(30) = -.09, p > .20$) were observed. The same patterns were observed when the LH and RH participants were analyzed separately (Table 2).

To explore group differences in degree of neurological impairment, perceived stress, and depression for all time points, independent samples t-tests were performed separately on the

overall means of the three corresponding measures (*SSS*, *PSS*, and *SADQ*). Participants in the LH and RH groups did not differ significantly on the measure of stroke severity (*SSS*; $t(29) = -1.11, p > .20$), nor on perceived stress (*PSS*; $t(29) = .04, p > .20$) or depression (*SADQ*; $t(28) = -.73, p > .20$).

To examine group differences in changes over time, separate mixed-design analyses of variance (ANOVAs) were performed for each of the three measures, with two time points (first, last) as the within-subjects factor and group (LH, RH) as the between-subjects factor. Because many of the participants had missing data points on one or more of the measures, a repeated measures analysis that incorporated all four time-points would have severely limited the number of participants in the analysis. Therefore, a “First Measurement” variable was created for each participant on each measure that consisted of that participant’s score the first time the measure was administered (whether it was the first or second session). Similarly, a “Last Measurement” variable indicated the participant’s score on the last time the measure was administered (whether it was the third or fourth session). This manipulation allowed every participant to have data for each measure that corresponded to their scores early in the study and late in the study. Results of these mixed-design ANOVAs are reported in Table 3.

In the analysis conducted for *SSS*, there was a large main effect of time but no significant effect of group and no interaction. It therefore appears that both groups experienced similar levels of significant neurological improvement from their first *SSS* measurement to their last. In the analysis for *PSS*, there was no significant main effect of time or group. However, there was a marginally significant interaction of time and group. This moderate-to-large effect size (Cohen, 1973) suggests that, despite the small sample size, there is a trend toward the LH group reporting less stress from the first to the last administrations of the *PSS*, while the RH group tended to report more stress (Figure 1). In similar analyses on the *SADQ*, the effect of time was a trend that did not approach statistical significance; however, the effect size was nonetheless moderate. There was no main effect of group or interaction of time and group. Thus, both groups reported a trend toward the same degree of change in depressive symptoms from the first to the last administration of the *SADQ*.

Given the range of time post stroke (1–6 months) at which participants enrolled in the study, post-hoc analyses were conducted to determine effects of time at study initiation on the mean *SSS*, *PSS*, and *SADQ* scores. As in Laures-Gore (2012), the median split for each group for the time post-onset at enrollment was calculated: *Mdn* LH = 2.03 months, $N = 10$ (early), $N = 9$ (late); *Mdn* RH = 1.76 months, $N = 6$ (early), $N = 6$ (late). Separate independent samples t-tests were conducted for each group (LH and RH) on each of the three measures. There were no differences that approached significance between the early- and late-starting participants on any measure for either the LH or RH groups.

Discussion

The current study examined the relation between perceived stress, depression, and neurological impairment in post-stroke patients. Higher levels of perceived stress are associated with depressive symptoms and are independent of the severity of neurological impairment in both right- and left-hemisphere stroke survivors. This finding demonstrates that the perception of stress is an important variable in PSD. Previous studies have focused on communication, cognitive or physical impairments, as well as other stable factors such as sex or pre-stroke depression diagnosis (Berg et al., 2003; Hackett et al., 2005; Hilari et al., 2010; Kauhanen et al., 2000; Kellermann et al., 1999; Nys et al., 2006; Ouimet, Primeau, & Cole, 2001). However, it appears that the perception of stress should also be considered as a

predictor of PSD. These findings have important clinical implications for determining who may be at risk for developing PSD.

Although the lack of relation between neurological functioning and either depressive symptoms or perceived stress in this sample of stroke patients was not expected, it does align with the notion that the number of stressors is less important than the perception of stress in developing physical symptoms and reporting distress (Bolger & Schilling, 2006). It is possible that the highly individualized nature of stress perception may be the culprit in the difficulty determining which previously considered variables could lead to PSD (Ayerbe et al., 2013; Hackett et al., 2005).

Only a handful of studies have looked at perceived stress in stroke patients. Ostwald and colleagues (Ostwald, Godwin, & Cron, 2009; Ostwald et al., 2008) found that stroke survivors reported less perceived stress as stroke recovery and functional independence improved. The current findings from the sample as a whole do not correspond with these previous findings as perceived stress did not change as neurological functioning improved. However, current results are consistent with Ostwald et al.'s (2008) finding that depression and perceived stress in a group of stroke survivors are related. Ostwald et al. (2008) interpreted this relationship to indicate that depression predicted perceived stress, whereas the current conceptual point is that perceived stress predicts depression. Obviously, a research design permitting conclusions about causality is necessary.

If future analysis reveals a causal relation between perceived stress and depression, routine screening of perception of stress may need to occur in post-stroke patients to avoid development of depression. Because the perception of stress partially depends on an individual's coping resources (e.g., acceptance, confidence, financial freedom, social support, tension control, stress monitoring), mental health and health professionals could focus on the coping resources available to patients with higher perceived stress scores. This suggestion has been addressed previously by Dubay, Laures-Gore, Matheny, & Ronski (2011); in left hemisphere stroke patients with aphasia and right hemisphere stroke patients, perceived coping resources were fewer than neurologically intact individuals. Acceptance [the understanding that weaknesses, flaws, and frustrations are normal and should not be a subject of focus (Curlette, Aycock, Matheny, Pugh, & Taylor, 1992)] was especially diminished in both stroke groups. Interestingly, stress monitoring and tension control, coping resources related to one's awareness of personal stress levels and ability to reduce tension, were lower in left hemisphere stroke patients with aphasia than the right hemisphere stroke patients. This suggests that consideration of stroke location in the counseling of stroke patients would need to be considered as well.

While perceived stress and depressive symptoms are associated in the present sample as a whole, the trend toward more depressive symptoms over time and a split between LH and RH reports of perceived stress (increased perceived stress over time in RH, but decreased in LH) demands further attention. Given the large effect sizes with this small sample, it is predicted that a significant finding may result from a larger sample size. Although speculative in nature, it is plausible that because RH patients often are unaware of their deficits (Jehkonen, Laihosalo, & Kettunen, 2006; Korte & Hillis, 2009), they begin to perceive more stress as they progress through stroke recovery and their awareness deficits lessen. In contrast, the LH patients may be more aware of their deficits earlier in recovery and therefore, have more time to accept their deficits resulting in less perceived stress.

A few limitations of this study should be considered, foremost is the small sample size. Inclusion of a larger sample size may reveal significant differences in LH and RH changes in depression and perceived stress that instead were limited to trends. In addition, there was

a relatively wide range in time post stroke at study enrollment (1–6 months). No differences were found in this sample on any measure for those enrolled earlier versus later in this time span. However, it is possible that the relationship between PSD, perceived stress, and neurological functioning evolves during this early time period and that this evolution may have been detected with a larger sample size. Furthermore, selection of psychometrically sound instruments to assess the internal states of depression and perceived stress is limited by language considerations in individuals with aphasia. The *SADQ* was designed specifically to detect depression in individuals with aphasia by caregiver observation of behaviors associated with depression (e.g., crying, anger, social withdrawal). While it was developed in individuals with aphasia (Sutcliffe & Lincoln, 1998), the *SADQ* was validated against self-report measures in stroke patients without significant language impairments (Leeds et al., 2004; Sackley et al., 2006). It is possible that caregiver ratings of depression-related behaviors were influenced by the history of ongoing linguistic communications with the individuals without aphasia. In contrast, there appears to be no standardized measure of perceived stress specifically designed for individuals with aphasia. The *PSS* is appropriate for those with a junior high school education or higher (Cohen et al., 1983); however, for some individuals with aphasia this reading level may still be challenging. To avoid this confound, either the investigator or a friend/spouse/caregiver read the questions along with the participant to aid in comprehension. Answers were given by the individual with aphasia. This introduces the potential for respondent bias, although Cruice, Worrall, Hickson, and Murison (2005) did find good agreement between proxy and aphasia respondents while assessing psychological well-being. Development of perceived stress measures sensitive to individuals with linguistic impairments are needed.

Overall, the current study is an additional step toward better understanding variables associated with PSD. The findings suggest that perceived stress is related to depressive symptoms and is independent of neurological impairment. Future research should continue to explore perceived stress, depression, and stroke with larger sample sizes and designs that can reveal causality of perceived stress and depression.

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Figure 1.
Mean *Perceived Stress Scale (PSS)* scores by group over time.

Table 1

Mean Scores and Standard Deviations by Participant Group and Measurement Time

		<i>M</i> (<i>SD</i>)	<i>N</i>	<i>Min</i>	<i>Max</i>
Overall					
<i>SSS</i>	All	38.54 (7.76)	31	18.75	48.00
	LH	37.32 (8.49)	19	18.75	47.00
	RH	40.48 (6.30)	12	27.75	48.00
<i>PSS</i>	All	22.23 (9.50)	31	1.00	43.50
	LH	22.29 (7.91)	19	9.67	37.50
	RH	22.14 (11.99)	12	1.00	43.50
<i>SADQ</i>	All	12.01 (4.44)	30	5.67	22.50
	LH	11.55 (4.54)	19	5.67	22.50
	RH	12.80 (4.38)	11	9.00	21.00
Time 1					
<i>SSS</i>	All	36.42 (9.01)	31	13	48
	LH	35.37 (9.29)	19	13	45
	RH	38.08 (8.68)	12	18	48
<i>PSS</i>	All	23.68 (10.62)	25	5	44
	LH	23.13 (10.96)	15	5	43
	RH	24.50 (10.62)	10	8	44
<i>SADQ</i>	All	10.84 (5.16)	25	4	24
	LH	10.07 (4.92)	14	4	20
	RH	11.82 (5.53)	11	5	24
Time 2					
<i>SSS</i>	All	37.97 (8.92)	30	13	48

	<i>M (SD)</i>		<i>N</i>	<i>Min</i>	<i>Max</i>
<i>PSS</i>	LH	36.58 (9.63)	19	13	48
	RH	40.36 (7.35)	11	29	48
	All	21.83 (10.17)	29	0	43
	LH	22.72 (7.93)	18	6	35
	RH	20.36 (13.38)	11	0	43
	All	12.30 (5.19)	23	3	24
<i>SADQ</i>	LH	11.85 (5.67)	13	3	24
	RH	12.90 (4.73)	10	8	20
	All	39.88 (7.69)	25	20	48
	LH	38.47 (8.26)	15	20	48
	RH	42.00 (6.57)	10	29	48
	All	21.71 (11.50)	28	2	50
<i>PSS</i>	LH	22.00 (9.62)	17	4	38
	RH	21.27 (14.43)	11	2	50
	All	12.45 (4.92)	22	7	25
	LH	11.25 (4.07)	12	7	19
	RH	13.90 (5.65)	10	7	25
	All	40.42 (6.83)	31	21	48
<i>SADQ</i>	LH	39.53 (7.79)	19	21	48
	RH	41.83 (4.91)	12	35	48
	All	22.03 (11.74)	29	1	44
	LH	19.65 (10.09)	17	4	40
	All	40.42 (6.83)	31	21	48
	LH	39.53 (7.79)	19	21	48
<i>PSS</i>	RH	41.83 (4.91)	12	35	48
	All	22.03 (11.74)	29	1	44
	LH	19.65 (10.09)	17	4	40
	All	40.42 (6.83)	31	21	48
	LH	39.53 (7.79)	19	21	48
	RH	41.83 (4.91)	12	35	48

	<i>M (SD)</i>	<i>N</i>	<i>Min</i>	<i>Max</i>
	RH	25.42 (13.48)	12	1
				44
<i>SADQ</i>				
	All	12.00 (4.22)	23	4
				21
	LH	12.00 (5.13)	15	4
				21
	RH	12.00 (1.85)	8	9
				15

Table 2

Bivariate Correlation Table for LH and RH Participants

Group	Measure	SSS	PSS	SADQ
LH ($n = 19$)				
	SSS	-		
	PSS	.07	-	
	SADQ	-.26	.57*	-
RH ($n = 12$)				
	SSS	-		
	PSS	-.15	-	
	SADQ	.27	.71*	-

*
 $p < .05$

Table 3

Mixed-Design ANOVAs of Differences Between Groups and Over Time.

	Group effect				Time effect				Interaction			
	df	F	p	partial η^2	df	F	p	partial η^2	df	F	p	partial η^2
<i>SSS</i>	1, 29	.81	> .20	.027	1, 29	15.64	< .001	.35	1, 29	.04	> .20	.001
<i>PSS</i>	1, 29	.09	> .20	.003	1, 29	.27	> .20	.009	1, 29	3.37	.077	.104
<i>SADQ</i>	1, 28	.30	> .20	.01	1, 28	2.34	.14	.077	1, 28	.003	> .20	.000