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Emotional Perception Deficits in Amyotrophic Lateral Sclerosis

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Abstract

Objective—Cognitive deficits associated with frontal lobe dysfunction can occur in amyotrophic lateral sclerosis (ALS), particularly in individuals with bulbar ALS who can also suffer pathological emotional lability. Since frontal pathophysiology can alter emotional perception, we examined whether emotional perception deficits occur in ALS, and whether they are related to depressive or dementia symptoms.

Methods—Bulbar ALS participants (n = 13) and age-matched healthy normal controls (n = 12) completed standardized tests of facial and prosodic emotional recognition, the Geriatric Depression Scale, and the Mini-Mental State Examination. Participants identified the basic emotion (happy, sad, angry, afraid, surprised, disgusted) that matched 39 facial expressions and 28 taped, semantically neutral, intoned sentences.

Results—ALS patients performed significantly worse than controls on facial emotional recognition but not on prosodic emotional recognition. Eight of 13 patients (62%) scored below the 95% Confidence Interval of controls in recognizing facial emotions, and 3 of these patients (23% overall) also scored lower in prosody recognition. Among the 8 patients with emotional perceptual impairment, one-half did not have depressive, or memory or cognitive symptoms on screening, while the remainder showed dementia symptoms alone or together with depressive symptoms.

Conclusions—Emotional recognition deficits occur in bulbar ALS, particularly with emotional facial expressions, and can arise independent of depressive and dementia symptoms or co-morbid with depression and dementia. These findings expands the scope of cognitive dysfunction detected in ALS, and bolsters the view of ALS as a multisystem disorder involving cognitive as well as motor deficits.

Key search headings

Emotion; Amyotrophic Lateral Sclerosis; Perception

INTRODUCTION

Although cognitive and social-emotional deficits have not been associated historically with amyotrophic lateral sclerosis (ALS), recent research suggests that such impairments are identifiable and may play an important role in medical decision-making and care-giving issues.^{1–6} The deficits can be evident in behavioral domains closely associated with the prefrontal

cortex including executive functions and social cognition. Furthermore, deficits may occur in up to one-half of all non-demented ALS patients, most particularly in individuals who suffer from early bulbar ALS.

Cognitive impairments are themselves disabling, but they can also exacerbate or provide the basis for alterations in patients' interpersonal processing and social-emotional adaptation. Emotional perceptual problems, specifically an inability to interpret emotional facial expressions and/or vocal intonations, can occur in many different neurological disorders. It has been associated with vascular as well as neurodegenerative pathophysiology affecting prefrontal and right posterior cortical regions as well as frontal-subcortical circuits.⁷⁻¹⁶ Importantly, emotional processing deficits can occur independent of depression and dementia, such as in Parkinson's disease.¹⁷ Disturbances in emotional recognition may reduce patients' involvement in diverse relationships and activities, decrease their quality of life, increase caregiver burden, and aggravate mood and behavioral disturbance.^{8,10}

Although patients with bulbar type ALS are known to suffer from pathological emotional lability, it is unclear whether they have difficulty perceiving and interpreting interpersonal emotional communications. There are several reasons for suspecting such difficulties in bulbar ALS patients. ALS can be associated with progressive mental decline that specifically affects frontal cortex ("frontotemporal dementia.")¹⁸ Individuals with ALS are reported to be impaired in attending to and recalling emotional words¹⁹ and frontotemporal dementia has been linked more generally with difficulty interpreting emotional facial expressions.¹⁴ Individuals with ALS also may have abnormal frontal lobe metabolism on functional imaging, even when they do not meet criteria for dementia,²⁰ and pathophysiology of frontal cortical systems is known to cause severe emotional abnormalities, including pathological indifference and impaired emotional regulation.^{21,22} Thus, individuals with ALS may have abnormal emotional behavioral experiences as well as abnormal emotional perceptual abilities as a result of altered bifrontal cortical function.

This study was designed to examine whether a pilot group of patients with ALS demonstrate emotional perceptual processing impairment, and to determine whether such emotional processing deficits could be accounted for by co-occurring dementia and/or depressive symptoms.

METHODS

Participants

Thirteen consecutive patients (5 men, 8 women) with Clinically Definite or Clinically Probable – Laboratory Supported bulbar-predominant ALS²³ were recruited through the Penn State Milton Hershey Medical Center ALS clinic along with 12 healthy controls, and all provided informed consent for a protocol approved by the Institutional Review Board. Subject characteristics and neuropsychological summary data are presented in Table 1.

Procedures

ALS patients and controls completed the Mini-Mental State Examination (MMSE),²⁴ the Geriatric Depression Scale (GDS)²⁵ and two emotional recognition tasks.^{26, 27} The Mini-Mental State, which contains items assessing select memory and cognitive functions (largely stored knowledge and "crystallized" abilities) is a poor screening instrument for the abnormalities of planning, organization, or conative function which may occur in ALS-related dementia. Nonetheless, it remains the most commonly used instrument for assessing mental function in this and other neurological settings. A modified version of the MMSE was used to accommodate those ALS patients who could not speak. In these instances, patients were

permitted to write answers, or the question was omitted if writing was not possible. Because some patients could not complete all 30 items on the MMSE, scores were pro-rated and converted to percentages, with performance below 88% defined as consistent with dementia symptoms (equivalent to a MMSE score of $\leq 26/30$). On the GDS, scores above 9 were defined as suggestive of depressive symptoms, with scores over 19 indicating severe symptoms. Subjects completed two emotional recognition tasks: (1) identifying emotional facial expressions from the Ekman series and (2) identifying emotional prosodic intonation of recorded neutral sentences (hereafter referred to as the Emotional Faces and Prosody tasks). 26–28

In the Emotional Faces task, subjects were presented with 39 standardized black-and-white photos of various emotional facial expressions (3 neutral, 6 each of happy, sad, angry, afraid, surprised, disgusted) in randomized order and were instructed to say or point to a word depicting the emotional expression. Response choices (the words: happy, sad, angry, afraid, surprised, disgusted, neutral) were printed on a set of seven cards and displayed in clear view of the subject during testing. Next, subjects listened to a tape recording of 28 standardized emotionally-intoned sentences (Prosody task). Four semantically neutral sentences (e.g. “She has a pencil”) were recorded in random order with each of the following emotional intonations: happy, sad, angry, afraid, surprised, disgusted, and neutral. Subjects chose an emotion from the response choice cards to match the emotional intonation of each recorded sentence which was played only once. In both tasks, if subjects were not sure how to answer, they were asked to guess.

Because of inadvertent missing stimuli (two angry faces and one happy face), six of the 13 patients and all controls saw only 36 total faces, with scores subsequently pro-rated for those 2 emotions. Twelve of the 13 ALS patients and all controls completed the entire Prosody task. In order to compare performance across tasks, scores for the MMSE, Emotional Faces and Prosody tasks were converted into percent accuracy scores.

RESULTS

Although controls were slightly older and more educated than ALS patients, no statistical differences were found. Results of experimental measures are summarized in Table 1. Five of 13 ALS participants (38%) met screening criteria for memory and cognitive dysfunction vs. zero controls while 4 of 13 (31%) met screening criteria for depressive symptoms vs. zero controls. The ALS sample overall had significantly lower MMSE scores ($t = -2.16, p < .05$) and significantly more depressive symptoms ($t = 3.89, p = .002$) than controls.

Patients completed the Emotional Faces recognition task with a mean accuracy of 68.59% which was significantly lower than the control mean of 81.94% ($t = -2.87, p = .011$). The Emotional Faces responses were also analyzed according to the 7 emotional choices (i.e., happy, sad, angry, afraid, surprised, disgusted and neutral). ALS patients’ mean (M) recognition of several emotions fell below a 95% Confidence Interval (CI) of control performance. These emotions were sad (ALS M = 56.41%, SD = 25.04; Controls CI lower-bound = 76.09%), disgusted (ALS M = 57.69%, SD = 35.10; Controls CI lower-bound = 75.06%), angry (ALS M = 71.79%, SD = 22.96; Controls CI lower-bound = 72.99%) and surprised (ALS M = 83.33%, SD = 15.21; Controls CI lower-bound = 90.86%). Of these 4 emotions, 3 had statistically significant differences between groups (sad: $t = -3.47, p = .002$; disgusted: $t = -2.53, p = .022$; surprised: $t = -2.57, p = .017$).

Patients completed the Prosody recognition task with a mean score of 62.80% correct vs. controls mean accuracy of 67.56%. Although the mean ALS performance fell just below a 95% Confidence Interval of control performance (lower-bound = 62.88%), there was no significant

difference between the groups ($p > .05$). When responses to Prosody items were analyzed according to the 7 emotional choices, only the ALS patients' recognition of surprise fell below a 95% Confidence Interval of control performance (ALS $M = 85.42\%$, $SD = 19.82$; Controls CI lower-bound = 86.57%).

These results are consistent with emotional perceptual impairment of facial expressions in the majority of the ALS sample as well as a high incidence of abnormal cognitive and depressive symptoms. Eight of the 13 ALS patients (62%) had emotional facial recognition scores that fell below a 95% Confidence Interval for the controls (lower bound = 77.52%). Of these 8 ALS patients, 4 (50%) had neither depressive nor memory and cognitive (dementia) symptoms on screening; two (25%) had both depressive and dementia symptoms; and 2 (25%) had dementia symptoms only. Of the 5 ALS patients whose scores remained within the controls 95% CI, 3 had neither depressive nor dementia symptoms, 1 had both dementia and depressive symptoms, and 1 had depressive symptoms only. None of these frequencies approached significance. Three ALS patients (23%) had Prosody recognition scores below the 95% Confidence Interval for controls (lower bound = 62.88%) while another 3 were below the control mean but above the CI lower bound. Of the 3 patients with impaired Prosody recognition, all had impaired Emotional Face recognition; 2 had neither memory and cognitive nor depressive symptoms on screening; and 1 had dementia symptoms. In total, 8 of the 13 ALS participants had either impaired Emotional Faces or Prosody recognition in comparison to controls.

Correlational analyses in the ALS sample indicated that scores on the Emotional Faces and Prosody tasks were moderately inter-related ($r = 0.688$, $p = .013$, 2-tailed). The GDS was not correlated with either the Emotional Faces or Prosody scores. MMSE scores showed a moderate correlation with the Emotional Faces accuracy ($r = 0.614$, $p = .025$, 2 tailed) and a trend toward correlation with Prosody accuracy ($r = 0.513$, $p = .088$, 2 tailed).

DISCUSSION

Imprecise perception on Emotional Face and Prosody tasks supports the conclusion that emotional perceptual deficits can be identified in patients with bulbar ALS. In one-half the patients demonstrating emotional perceptual deficits, we detected neither abnormalities on mental status screening, nor depressive symptoms to account for the abnormality. Thus, changes in emotional perception may be separable from the specific effects of memory and cognitive impairment and depressive symptoms on relevant brain systems. Of the remaining ALS patients with emotional perceptual deficits, all showed memory and cognitive symptoms on mental status screening (3 of the 4 just below the screening cut-off score) and one-half also showed moderate depressive symptoms. Thus, memory, cognitive and depressive symptoms may contribute to emotional perceptual impairments but are not necessary to cause them. Interestingly, the Emotional Faces task proved more difficult for the ALS patients, with 62% scoring below the 95% Confidence Interval for controls, while 23% scored below the 95% Confidence Interval for controls on the Prosody task. Of those patients who were impaired in Prosody, all were also impaired in Emotional Faces recognition. No participant showed isolated impairment in Prosody

Pragmatically, our research results bear on the common assumption that ALS patients' mental and cognitive abilities remain intact during the progression of their disease. This belief has traditionally shaped clinical care in ALS, such that many patients are asked to make complex end of life decisions when ALS is quite advanced, as they are assumed competent to make judgments significantly affecting the welfare of their loved ones as well as their own interests. The scope of such decisions is broad, and may include health related issues such as gastrostomy tube placement, noninvasive positive pressure ventilation, and mechanical ventilation, as well as financial and legal issues, including wills and inheritances. Although it could be argued that

recent studies demonstrating frontal-related cognitive and social judgment abnormalities in ALS already call these practices into question, we believe that the current results, although limited to a small group of patients with bulbar ALS, provide further evidence for a need to revise clinical attitudes toward the ALS patient. End of life decisions draw heavily on patients' interpersonal judgment and ability to perceive emotional signals and act appropriately, and thus any impairment in emotional processing may also limit patients' ability to make decisions and participate in their own care.

There are limitations to this study that can be addressed in further research. The screening measures chosen to detect memory, cognitive, and depressive symptoms are not sensitive to more subtle symptoms and to certain specific cognitive impairment likely to occur in ALS. The modified MMSE to accommodate patients' inability to speak may have further reduced its already limited sensitivity to detect cognitive dysfunction. This instrument is a poor screening tool for the planning, organization, or conative abnormalities common in early frontotemporal cortical impairment, as may occur in ALS-related dementia. However, it is still the most familiar and commonly-used cognitive screening tool in medical and neurological settings, and a number of subjects performed in an impaired range on the modified Mini-mental State (38% in this small pilot sample). Instruments are also needed to assess the relationship between emotional recognition deficits and other key capacities (e.g., interpersonal, caregiver-patient communication, decisional). Finally, it would be beneficial to replicate and generalize these results by testing emotional perceptual ability, mental function, and mood in a larger group of ALS patients with both limb- and bulbar-predominant symptoms, from diverse backgrounds.

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Table 1
Demographic and neuropsychological data for Bulbar ALS and Control participants.

ALS Patients	Subjects	Age, yr (s.d.)	Education, yr (s.d.)	GDS (s.d.)	MMSE (s.d.)	Faces (s.d.)	Prosody (s.d.)
n = 8	Women	64.67 (20.65)	13.33 (2.07)	11.43 (7.32)	85.80% (12.79)	65.52% (15.89)	64.29% (16.62)
n = 5	Men	60.80 (17.63)	12.60 (0.89)	6.00 (3.87)	94.17% (07.06)	73.50% (14.92)	60.71% (18.39)
n = 13	Total	62.91 (18.48)	13.00 (1.61)	9.17 (6.52)	89.02% (11.40)	68.59% (15.42)	62.80% (16.64)
Controls							
n = 8	Women	69.38 (8.83)	14.00 (2.39)	1.75 (2.71)	96.67% (3.56)	84.38% (7.26)	65.63% (7.62)
n = 4	Men	72.00 (2.94)	15.00 (2.00)	0.75 (0.96)	95.00% (1.92)	77.08% (3.50)	71.43% (6.52)
n = 12	Total	70.25 (7.33)	14.33 (2.23)	1.42 (2.27)	96.11% (3.12)	81.94% (7.06)	67.56% (7.53)

NOTE: GDS = Geriatric Depression Scale score, of 30, scores above 9 indicate depression; MMSE = Mini-Mental State Examination score, percentage out of 30, scores below 88.00% indicate dementia. Faces % = Percent correct recognition on faces task. Prosody % = Percent correct recognition on prosody task. Percentage scores are shown for MMSE, Faces task and Prosody task for cross-task comparisons.